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Cover Photograph

"*The year's at the Spring,*" *as seen in a riverside pasture in Kent.*

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

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THE WORLD FOOD SITUATION

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World food production is not keeping pace with the population. A tremendous concentrated effort on the part of farmers and scientists is necessary if the danger of starvation in many backward countries is to be averted. Professor Sir James Scott Watson here indicates some of the ways in which the Food and Agriculture Organization is tackling its vital task of promoting agricultural research and education in the face of social, economic and technical difficulties.

THE task of the world's farmers is becoming progressively more difficult. The fact of outstanding importance is, of course, the growing number of consumers. The last complete estimate of world population, made in 1949, gave a figure of 2,378 millions, and the subsequent increase may probably have been about 75 millions. Since there is no prospect of any comparable addition to the total area of farm land, and since there is a continuing wastage of soil by erosion, there are no means, other than improved farming methods, by which the present levels of nutrition, deplorably low as they are in many countries, can be maintained.

The progress of farm production, during the past dozen years, has clearly not been fast enough. It is reckoned that during this period the total acreage of food crops has increased by about 3 per cent, and that yields per acre have risen by about 6 per cent, making an overall increase in food output of 9 per cent. Meantime, population has risen by 13 per cent.

Many books have been written about the problem, and some of these reach the conclusion that wholesale famine may probably occur at some time well within the coming century. Others, more optimistic, point to the fact that in the "advanced" countries population is well on the way to becoming stabilized, and indeed that some decrease would seem likely during the coming generation. They go on to discuss the possibility that this tendency may spread throughout the world ; meantime, it should be noted that the trend towards stable population numbers is confined to countries whose combined populations make up only some 10 per cent of the world's total. Still other writers point to the possibility of quite revolutionary changes in methods of food production—the extraction of food protein from plant leaves, the synthesis of food fat from coal (which was actually carried out in Germany during the last war) and the more remote possibility of harnessing atomic energy to make sugar from the air.

If we take a shorter view—looking no further ahead than the next few decades—it is obvious that the risk of out-and-out starvation varies, according to the circumstances, as between individual countries. Firstly, in the

United States, Canada, Sweden, and France, where populations are tending to become static and current net reproduction rates point to a decline, land resources are at least adequate to provide for existing numbers and it may be confidently expected that agriculture will continue to make rapid progress.

Second is a group including Russia, Argentina, Brazil and large parts of Africa whose land resources are sufficient not only to cover likely requirements for many years to come but to produce a surplus for export as well, and where, therefore, there is large scope for agricultural expansion and intensification. Since, taking the world as a whole, industrial production is increasing considerably faster than food production, such countries can expect a continuing improvement in their terms of trade, and thus should have a strong incentive to increase food production for export.

The third group—by much the largest in terms of population—includes areas like India and Pakistan, the Middle East, limited parts of Africa and the West Indies, where nutritional standards are already extremely low, where the area of land per head of population is small and birth rates are high, and where the illiteracy of the great majority of farmers, unsatisfactory conditions of land tenure, traditional habits of thought and sometimes religious beliefs, add up to a formidable system of brakes upon progress. Since these countries are backward in industrial development as well as in agriculture, they are in no good position to pay for food imports by means of other goods or services. In a sense such improvement in medical services as has already taken place has served to aggravate the problem of food, and further advances in medical science will inevitably have like consequences. The remaining scope for such advances is large ; in India, for example, the present expectation of life of the average infant is 23 years, which figure compares with 40 in Britain and 43 in Sweden. The food position in these backward countries has deteriorated fast in recent years. It is not so long ago that India was the second largest exporter of wheat; today she must import some eight million tons of cereals annually in order to ensure a bare subsistence for her people.

The other group of vulnerable countries includes, as extreme examples, Holland, Britain and Japan. Land resources, intensively used as they are, fall far below what would be required to maintain existing levels of nutrition—reasonably good in the two first but dangerously low in the last—and there is the further difference that net reproduction rates are low in Holland and Britain but high in Japan. All these countries have lived, for the last generation or more, by buying food with the proceeds of manufactured exports or by earnings from shipping, trading and other services. It is obvious that the progressive change in terms of trade—the relation between prices of food and raw materials on the one hand and those of manufactured goods on the other—is bound to place this type of economy at a disadvantage, with the consequent need to be wary of high imports and to expand exports.

The Conception of F.A.O. The need for an international approach to this complex of problems was recognized in the calling of the Hot Springs Conference in 1943 and, as an outcome, the setting up of the United Nations Food and Agriculture Organization. At Hot Springs, and later when the powers and functions of F.A.O. were under discussion, there was some divergence of view. Memories of the 'thirties were still fresh—memories of prairie grain, worth only a few cents a bushel, bursting the available storage capacity, of mass slaughter of baby pigs, and of a coincident fall in nutritional levels both in the "advanced" and the "under-developed" countries. Hence the representatives of the food-

exporting countries and also those of countries in direct need of food, conceived of an organization whose main function would be to control the production and distribution of staple foods : for instance, it would create large reserves of grain in times of abundance and distribute these, at less than world prices if necessary, in case of a threat of famine in any part of the globe. Thus the food producer would not be discouraged by periodic price slumps in his efforts to produce more.

The other conception, which would so far seem to have been the better, was that the chief function of the organization should be to help countries to help themselves—to promote agricultural research and education, to assist in the setting up of advisory and other technical services, to provide a clearing house of information about nutritional needs and food supplies and to take or to organize international action wherever it seemed necessary for satisfactory results.

It is possible here to do no more than indicate the various aspects of F.A.O.'s activities.

The more fundamental type of research is, of course, the main foundation of progress, but its results are, so far as the free world is concerned, made freely available to all. There is indeed the large problem of ensuring that research workers throughout the world are kept informed about the progress being made by others in their respective fields, and the Preparatory Commission did consider whether F.A.O. should establish a clearing house for discoveries and inventions ; it reached the conclusion, however, that our own Commonwealth Agricultural Bureaux were already providing as good a service as F.A.O. could hope to give. Where, however, a particular country is considering new plans or projects, F.A.O. can and does arrange to make available expert advisers, sometimes from its own staff but more usually others selected for their special competence.

Obstacles to Progress The rate at which new knowledge and new resources are applied, in the field and in the cowshed, varies very widely between one country and another. The difficulties are least where the farming community is well educated, and has opportunities to read, to hear about, or to see new developments. The rate drops almost to zero where illiteracy, lack of communications, and the lack of trained advisory and technical staffs are combined, as they normally are, with undue respect for ancient tradition. But something can be done even under such conditions—largely through the system of making use of the more progressive individuals and using their farms as demonstration centres. Here again, countries have been able to help each other through the good offices of F.A.O.

In many cases the obstacles to progress are social or economic rather than technical. If, as in many eastern countries, the peasants are perpetually in debt to "gombeen men" (merchant-moneylenders), their attitude tends to become one of hopelessness, and the remedy is to be sought in co-operative marketing and credit. In many over-populated and under-developed countries, landlords may be extortionate, and security of tenure may be non-existent. Again, over a great part of the world, and not only in backward areas, the physical layout of land is similar to that which existed in mid-England before the enclosures—individual holdings being composed of many bits and pieces scattered over the whole area appertaining to a village, with all the obvious disadvantages of rights of way, waste of land and loss of time. It is no small undertaking to carry through the process of land redistribution and consolidation, but it is being acomplished in not a few places.

The Technical Problems Even where a problem is essentially technical and technically simple, it may be greatly complicated by a variety of circumstances. Consider, for example, the problem of increasing milk production in the tropics. So long as the bulk of a rural community—children as well as adults—are suffering from chronic malnutrition there is, as would be expected, a general attitude of apathy and a lack of physical energy. The logical long-term approach must be to start with the children and hope to raise a new generation of energetic and alert people, and the major need to this end is an adequate milk supply. This implies better bred cattle, better fed and healthier. But in hot and humid climates, the direct approach—the introduction of improved dairy breeds—is ruled out because the improved breeds are adapted to cool-temperate conditions and cannot thrive in the tropics. In some cases new types have been created by crossing deep-milking, imported animals with the heat-tolerant, local breeds, but often this approach has failed. One is then driven back upon the process of long-continued selection of the native stock. But if the cattle of a whole community are run together on common grazings, this is difficult to apply in practice. One of F.A.O.'s publications summarizes past experience and offers the best available guidance.

Again, in many over-populated countries, the incidence of cattle disease is high and, in particular, the animals are liable to catastrophic epidemics of rinderpest. A vaccine is available which gives a high degree of protection, and this is being made widely available by F.A.O. But in India and in many African territories the number of cattle is already far too high—in the one case because slaughter is barred on religious grounds, and in the other because the social status of the owner is measured by the size of his herd, and because the " bride price " is paid in cattle. Hence, in certain cases, disease control may defeat its own end.

To take another example, rice is the staple food of a very large part of the human race, and in general the rice plant has not been subjected to the intensive study and the elaborate methods of improvement that have been applied to wheat, maize and other food crops. Individual breeders have produced improved varieties for particular environments, but the original pedigree material, when released to farmers, quickly becomes mixed with older and inferior stocks, and the benefit is thus lost. It would be an immensely progressive step if adapted strains could be produced for all the widely varying conditions under which rice is grown, and if an organization could be provided that would maintain a supply of tolerably pure stocks. This is perhaps the largest venture of its kind that F.A.O. has embarked upon.

But not all possible schemes are so complicated. From Biblical times one of the major causes of famine has been the desert locust, whose swarms have in the past arrived without warning and completely destroyed food crops over wide areas. The breeding habits and habitats are now known, and the work of the British-administered Desert Locust Survey and the Desert Locust Control Organization, the former mainly undertaking research into habits and movements and the latter dealing with actual outbreaks of the plague in our East African colonies, has brought a large measure of success. Appreciation of the value of the work of these organizations has now been shown by F.A.O. with the setting up of the Technical Advisory Committee on the Desert Locust to ensure more complete international co-operation. Much more action is possible along the lines that have been illustrated—the application of science by appropriate organization.

The world's food outlook is grave indeed. As has been said lately, the problem has been largely created by the uneven application of science. Disease, once the main check on population, is being rapidly brought under control through the development of medical science and the better organization of medical services. Agricultural science and organization have been neglected until it is almost too late. A united effort on the part of scientists and farmers will be needed if the situation is to be saved.

SOME ASPECTS OF PIG FEEDING

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In present circumstances more pigmeat can come only by greater use of home-grown protein and planned feeding from weaning to slaughter.

WITH the emphasis on maximum meat from our farms, it is inevitable that a good deal of attention should be focused on the pig. And certainly it has abundant potentialities. The offspring of one sow can furnish about a ton of carcass meat annually, increasing their birthweight a hundredfold in half a year. Unfortunately, the pig is rather exacting in its food requirements and is unable to thrive on the rough rations which satisfy the ruminant. It has a simple stomach and little ability to deal with fibrous foods. For this reason some of our home-grown foods are unsuited to it ; but we cannot import all the feedingstuffs we should like and remember, too, that there are now many more mouths clamouring to share in the allocation of imported concentrates. During 1951, the pig population increased by almost 1,200,000—that is 40 per cent more than in 1950 The problem to be solved, therefore, is how to fatten pigs as quickly as possible but with the minimum of rationed feedingstuffs, and this involves the closest scrutiny of the pig's needs at every stage of its life.

In the spacious pre-war days, it was common to feed pigs with a ration which remained unchanged in composition from weaning until slaughter. This practice ignored the fact that the material laid down in the body as " liveweight increase " is of very different composition at different stages in the pig's development. Like other animals, liveweight increase in the early stages is largely composed of protein (lean flesh), minerals (bone material) and water, while in the last stages of fattening the increase is largely plain fat. If, therefore, a ration provides the correct amount of protein for the young pig, it follows that the same ration will be wasteful of protein in the maturer animal. This waste we just cannot afford, neither financially nor in any other way, and the adjustment of rations to physiological needs is a cardinal point in present-day feeding.

Losses in Young Pigs There is a source of waste, however, which should be mentioned before proceeding further since, if it could be reduced, a considerable increase in pigmeat would result ; this is the discrepancy between the number of pigs farrowed and the number

which complete fattening. It would be cynically unfair to claim that the death of some of the litter is a relief in that it reduces the competition for concentrates! For one thing, a healthy litter will fatten more economically than one which has earlier struggled through disease; for another, we are still very far from having mobilized all our home food resources. Unavoidable losses there will always be; but in recent years knowledge has been accumulated which, if applied, could greatly narrow the gap.

A common ailment among very young pigs reared indoors is anaemia, due to a deficiency of iron. The sow's milk provides a negligible amount of iron, and the piglets are exposed to the very real danger of impoverished blood, with unthriftiness, poor resistance to disease, and death, as likely sequels. However, if the pigs are dosed with iron so that they are kept vigorous until they are about three weeks old and able to tackle a good creep feed, the danger is then largely past because the solid food will provide ample iron. Dosing should be carried out on the third, tenth and seventeenth days of life by dropping on to the tongue as much reduced iron as can be lifted on a sixpence, held like a spoon by the thumb and finger. Of course, if the pigs are run outside on soil or grass, they normally obtain adequate amounts of iron from the soil they pick up, and this is one reason why outside rearing is preferable. Likewise, indoor pigs benefit if turf or soil is made available to them.

The Importance of Warm Housing

Workers at the Rowett Institute, who have been active in this and other problems, recommend outdoor rearing in wooden arks as a preventive of anaemia, isolation against infection, and as a means of maintaining satisfactory temperatures. At first sight, it may seem peculiar to associate warmth with field arks as against permanent buildings, but it is true that many of the latter are of quite the wrong construction for pigs. They are too high, are draughty, and have cold concrete flooring, and a piglet kept in this kind of housing is liable to be so severely chilled that the blood flow to the liver will be interrupted. This causes a derangement in the work of the liver and the pig becomes unthrifty and often dies within a month and a half, or two months, of birth; if it survives, it does so as a runt.

Should it be necessary to rear pigs indoors, two requirements must be met. Iron must be provided, and the housing must be warm. At the same time, adequate arrangements must be made for dunging away from the resting places, otherwise ammonia and other gases arising from the fermentation of the excreta will cause irritation and predispose the piglets to respiratory troubles. A temperature of about 70°F. is best for young pigs, and the aim should be to provide this by every means possible. Interior wooden structures of low height can be used to convert unsuitable, high, concrete buildings.

The provision of warmth is equally important during the fattening process. If the house is cold, a large part of the food which ought to go towards weight increase has instead to be burned to maintain body temperature. It has been stated that a temperature of 60–65°F. is desirable for pigs approaching bacon weight; so, in general, it may be said that a range of ten Fahrenheit degrees covers the temperature requirements throughout life. All these temperatures are normally higher than that of the atmosphere and, if artificial heating is to be minimized or avoided, they can be obtained only by conserving the animals' own heat, due regard being paid to adequate ventilation.

The Creep Feed The creep feed should be of the best quality. This is true economy, because nothing is too good to assist the piglet over its early critical days and, in any case, the amount of food consumed is small. It should contain not less than 10 per cent of the best animal proteins (e.g., fishmeal and dried skim milk in equal parts) and about $2\frac{1}{2}$ per cent of steamed boneflour with $\frac{1}{2}$ per cent common salt. The animal protein will also supply vitamins, and this intake can be increased by 1 per cent of cod liver oil added fresh to each day's feed. Harsh foods such as palm kernel cake meal and coconut cake meal should be omitted from creep feeds. When weaning time arrives, it is necessary to make the change from the creep feed to the weaner's ration *gradually* so that disturbances may be avoided ; and the same action should be taken when changing from the weaner's to the fattening ration.

Conserving High-Protein Foods after Weaning From weaning onwards, the aim should always be to feed the pig adequately but with the minimum of costly and scarce high-protein foods. The only home-produced high-protein foods are of animal origin—white fishmeal, herring meal, meat and bone meal, etc.—and there is not enough of these for lavish use. As the pig grows and its daily intake of meal rapidly increases, the consumption of protein concentrates would leap alarmingly if vigilant action were not taken. It is possible to use moderate sources of protein, such as peas and beans, in partial replacement of animal protein. Although these are much poorer than the animal sources, they are nevertheless twice as rich as cereals ; also, if groundnut meal is available, three parts will replace two parts of fishmeal. In all cases where vegetable foods are used to replace fishmeal, it is necessary to add a mineral mixture to compensate for the loss of the fishmeal minerals.

We are indebted to Woodman(1) and his fellow-workers at Cambridge for demonstrating the extent to which high-protein foods may be saved. Pigs fed, from weaning up to 150 lb. live weight, on a ration containing 10 per cent fishmeal (this fishmeal thereafter being replaced by 5 per cent groundnut meal until slaughter) did no better than pigs given 7 per cent fishmeal up to 90 lb. live weight and no high protein at all thereafter ; mineral supplements were given, of course, where fishmeal was low or absent. The consumption of high protein concentrates in the first treatment was almost five times that in the second !

To interpret these findings in terms of actual feedingstuffs, specimen rations, which are both adequate and economical, are given below :

Low-Protein Rations Adequate for Fattening

	Weaning to 90 lb. L.W.		90 lb. L.W. to Slaughter	
Barley meal	60	55	75	65
Fine offals or fine bran ..	30	33	20	30
Grass or lucerne meal	3	5	5	5
Fishmeal	7	7	—	—
Mineral supplement*	$\frac{1}{2}$	$\frac{1}{2}$	2	2

* 3 parts by weight of ground chalk and 1 part common salt.

Considerable latitude can be exercised in the composition of the cereal portion, but it should be remembered that if the fibre content is much increased, the growth rate will be correspondingly reduced. If the latter consideration is not of first importance, it may be convenient to replace a large part of the barley with ground oats. Oats, ground in a hammer mill to

It is reckoned that grass can save 25 per cent of meal, and a clovery ley or lucerne requires only cereals in the meal plus a mineral supplement. Two points should be noted : grazing is not satisfactory in the last stages of fattening, and it is necessary to manage the grass or lucerne so that it is not allowed to grow away from the stock and become fibrous and of low-protein content. Dried grassmeal, dried lucerne meal and clover meal can be used to replace part of the miller's offals if they are of good quality. They can be given in amounts up to 15 per cent of the meal for young pigs and 10 per cent for fatteners.

Feeding Sows Sows can be maintained on 2 lb. meal, plus bulky foods such as fodder beet, potatoes, kale and grazing, during the first 2½ months of pregnancy, but thereafter the meal allowance should be steadily increased to 6 lb. at 3½ months[4]. The allowance should be 8 lb. at farrowing rising to a maximum at 6 weeks of 3 lb. plus 1 lb. per piglet. During the latter part of pregnancy, and throughout lactation until the piglets are well-established on creep food, the meal should contain adequate animal protein. Thereafter, the piglets will gain more benefit if the animal protein goes to them direct from the creep feed and thus the protein can be gradually withdrawn from the sow. After weaning, feeding of meal should again be on the 6–8 lb. level until oestrus has occurred and the sow is settled in-pig; the allowance can be subsequently reduced to the original 2 lb.

Mineral and Vitamin Requirements The value of iron to the piglet has already been discussed. The only other minerals likely to be required by pigs are lime, phosphate and common salt. In rations composed entirely of meals, there is plenty of phosphorus and the only supplement necessary is 1½ per cent limestone flour and ½ per cent common salt. Where roots are used, ½ lb. of the following mixture should be added for each 1 cwt. of the roots : 2 parts limestone flour, 2 parts bonemeal (or dicalcium phosphate), 1 part common salt ; the basal 2½ lb.-meal will, of course, have its own mineral supplement. If meal is being saved in early pregnancy, care should be taken to ensure that minerals are supplied with the roots. Trace elements will be necessary only if all the ration is home-produced on soil which is deficient in those elements.

Fishmeal, and meat and bone meal, are the only animal foods supplying lime and phosphate in quantity (10 per cent of either food will supply 2 per cent of these minerals) but all animal proteins contain useful amounts of the vitamins riboflavin and B_{12} ; riboflavin is present also in high-quality grassmeal. A point of interest is that a cold piglet requires twice as much riboflavin as a well-housed one. B_{12} is made by bacteria in the bowel and the sow has enough for her own needs from this source ; but when she is in-pig, more is needed. B_{12} and its carrier, animal protein, are therefore necessary in pregnancy, lactation and early life. It can be dispensed with after the pig reaches 75 lb., since the animal is then getting an internal supply from its own bacteria.

The other vitamins required are A and D. These can be supplied by sprinkling, once a week, 1oz. of fish liver oil over the meals of young pigs and growers ; pregnant and nursing sows should have 1 oz. daily. Where the food has the oil mixed with it beforehand, enough should be prepared to last only a day or two, as vitamin A is unstable in these conditions. If the mash contains grassmeal, the pig can itself make vitamin A from the carotene of the grass and the fish oil is then necessary only for vitamin D, which is stable.

A brief mention should be made of water requirements. These are bound to vary with season, temperature and type of food, but usually a suitable proportion will be between 2 and 3 parts of water to 1 part of meal. In-pig sows require a gallon or more of water, and lactating sows 4 or 5 gallons daily. Briefly summarizing then, the important features to be remembered are:

1. Warm, dry housing is essential.
2. Animal protein should be used when it is most needed—from late pregnancy to about 90 lb. live weight.
3. Savings in concentrates can be made by adopting the Lehmann system of feeding.
4. Minerals and vitamins should receive consideration.
5. Changes in rationing should be made gradually, the complete change being spread over some weeks.

In addition to the references to current work on pig feeding and management already included in this article, the writings of Shanks[5], Howie *et al.* [6,7], Heitman and Hughes[8], and McLagan and Thomson[9], on various aspects of housing and temperature, are of interest. The Lehmann system of feeding has been dealt with by Dunkin and Cooper[10] with particular reference to fodder beet, by McLagan and Nasr[11] for potato feeding, and by Braude and Mitchell[12,13], who record findings on the use of both of these foods. A noteworthy contribution on water requirements is that by Aitken[14].

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farm decreases, it would soon prove to be a disadvantage under present-day circumstances ; the saving in feeding costs would be smaller than the loss through a decreased volume of output.

It is therefore necessary to find another home-grown food, which either in itself, or together with hay, would be suitable for the purpose, namely, a substitute food (or foods) on which to base calculations of the cost of S.E. and P.E. Kale would seem best to fulfil this requirement. Although fodder beet would be even more suitable, it is, as yet, not widely known in this country and, for the purpose of this article, is better ignored. Mangolds would be another possibility, but its unit cost of nutrient is higher than that in several bulky foods of similar utility. Kale has a heavy yield of nutrients per acre, and therefore would not entail a diminution in the volume of output of stock and stock products. Unfortunately, its keeping qualities limit its usefulness in the substitution concept.

Therefore a compromise seems the best way out of this predicament, and the basic notional substitution cost of S.E. used for the determination of the notional cost of P.E. in home-grown foods is assessed as the mean of the costs of S.E. in meadow hay and in kale. The costs of production of these two crops are taken to be the average of a number of actual farm costs in the counties around Bristol. Their S.E. and P.E. values are taken from " Rations for Livestock," *Ministry of Agriculture Bulletin No.* 48, so the following figures can now be given :

	Cost per ton	*S.E.*	*P.E.*
Meadow hay	£4 16s. 9d.	32.0	3.2
Kale	£1 16s.10d.	10.3	1.5

Therefore, on the hypothesis that the unit value of P.E. is equal to that of S.E., the unit cost of S.E. will be :

$$\tfrac{1}{2}\left(\frac{\text{£4 16s.9d.}}{32.0 + 3.2} + \frac{\text{£1 16s.10d.}}{10.3 + 1.5}\right) = \text{2s. 11¼d. per unit of either S.E. or P.E.}$$

On the other hand, assuming the notional cost of P.E. to be double the unit cost of S.E., then the substitution unit cost of S.E. would be :

$$\tfrac{1}{2}\left(\frac{\text{£4 16s.9d.}}{32.0 + 6.4} + \frac{\text{£1 16s.10d.}}{10.3 + 3.0}\right) = \text{2s. 7¾d. per unit of S.E.}$$

This difference in the above two costs of S.E. is insignificant for all practical purposes. The first formula gives the unit cost of P.E. on the assumption that a unit of P.E. is at least equal to one of S.E., a conservative estimate for it could not be assumed that it was lower. On the other hand, although the second formula ascribes twice the value to a P.E. unit, there is the possibility of error in both directions. Therefore the first assumption will be adhered to.

Cost of Protein Equivalent It is now possible to proceed to determine the notional cost of P.E. in home-grown foods. The following symbols are used :

P.E. % = Protein equivalent value of the food
C.F. = Cost of growing the food crop
S.S.E. = Basic substitution cost of S.E. (i.e. 2s. 11¼d.)
S.E. = Starch equivalent value of the food
C.P.E. = Notional unit cost of P.E.

hence

$$\text{C.P.E.} = \frac{\text{C.F.} - (\text{S.S.E.} \times \text{S.E.})}{\text{P.E. per cent}}$$

ESTIMATING THE COST OF HOME-GROWN PROTEIN

In the following table the cost of P.E., calculated on the above method, is given for a number of home-grown foods and for dairy cake. It is based on the average costs for 1950 on certain farms in South-West England, and, for dried grass, on the costs of production in twelve Milk Marketing Board centres based on 1950 results adjusted for January 1952 costs. Dairy cake has been valued at current purchase price. Clearly such average costs can serve only as a rough guide for any particular case, since they are largely determined by yields and are therefore subject to major variations.

Table 1

Cost per Ton of Crops, Nutritive Values and Notional Unit Cost of Protein Equivalent
(Based on meadow hay and kale)

Crop	Cost per ton	Starch Equivalent: of Crop	Starch Equivalent: Total Notional Cost	Protein Equivalent: of Crop	Protein Equivalent: Total Notional Cost	Protein Equivalent: Notional Unit Cost	Protein Equivalent: Cost per cwt. P.E.
	£ s. d.	%	£ s. d.	%	£ s. d.	£ s. d.	£ s. d.
Meadow hay ..	4 16 9	32.0	4 7 8	3.2	8 9	2 9	13 8
Kale	1 16 10	10.3	1 12 2	1.5	4 8	3 2	15 8
Seeds hay	6 10 0	37.0	5 8 9	4.6	1 1 3	4 8	1 3 1
Oat straw	3 3 10	20.0	2 18 10	0.9	5 0	5 7	1 7 11
Grass silage ..	2 10 7	12.6	1 17 1	1.7	13 6	8 0	1 19 10
Arable silage ..	2 11 8	12.8	1 17 8	1.6	14 0	8 9	2 3 11
Swedes	1 15 2	7.3	1 1 5	0.7	13 8	19 7	4 17 11
Mangolds	1 9 1	6.5	19 2	0.4	10 0	1 4 11	6 4 6
Cabbage (Drumhead)	2 3 7	6.6	19 5	0.9	1 4 2	1 6 11	6 14 4
Beans	23 0 0	65.8	9 13 5	19.7	13 6 6	13 6	3 7 7
Dried grass (17% C.P.)	23 0 0	52.9	7 15 6	11.2	15 4 6	1 7 2	6 15 11
Oats	19 3 0	59.5	8 14 11	7.6	10 8 0	1 7 5	6 16 11
Dredge corn (20% beans)	22 17 4	65.0	8 1 9	10.0	14 15 8	1 9 7	7 7 10
Dried grass (13% C.P.)	21 10 0	49.4	7 5 3	7.3	13 14 9	1 17 8	9 8 2
Dairy cake ..	35 0 0	60.0	8 16 5	13.2	26 3 8	1 19 8	9 18 4

Table 1 is divided, for comparative purposes, into three parts, one containing data of bulky foods, another for concentrates, and the other for dairy cake. The costs of P.E. in the bulky foods reflect the relative advantages of growing the respective foods when grown at the given cost. These advantages are accentuated in the case of high-yielding crops, while they are offset by a low-yielding potential in crops demanding a higher acreage for the production of a unit of nutrient.

Thus swedes, mangolds and Drumhead cabbage have the advantage of high yield of nutrients per acre to offset the high unit cost of nutrient. A moderately good crop of those roots would produce three times and more the quantity of S.E. yielded by a mediocre crop of corn, beans (such as are, on average, produced in the west of England), or a usual crop of hay or grass silage, and about twice the total yield of P.E. than any of the above crops, except beans. At the yield level on which these calculations are based, beans exceed swedes and mangolds by about 18 per cent but are exceeded by the P.E. yield per acre of Drumhead cabbage which produce about 20 per cent more than an acre of beans. The extremely high unit cost of P.E. obtained

by the method used here indicates that the unit cost of S.E. in these roots is significantly higher than the average cost per unit of S.E. of meadow hay and kale, used for substitution. Meadow hay has the lowest notional cost of P.E. but its significance as a source of protein is small.

Among the remaining bulky foods, the unit cost of P.E. in seeds hay is considerably lower than that of grass and arable silage. This is at least partly due to the crop cost data available ; seeds hay at 28 cwt. per acre is not comparable to grass silage at 3½ tons per acre, or arable silage at 6 tons. There are seasons in which both the yield of hay is lower, on average, and the haymaking cost higher, when grass silage may easily show a unit-cost-advantage over seeds hay. Grass silage also has an advantage over hay in that it can be made throughout the growing season.

While arable silage shows a unit cost of P.E. only about 10 per cent higher than that of grass silage, its yield of protein per acre is 60 per cent, and that of S.E. 80 per cent higher than the nutrient yield of grass silage. On the other hand, arable silage has the disadvantage of a total or partial loss of aftermath grazing. Of the main protein producers in the bulky food category, kale combines the lowest cost per unit of P.E. with the lowest unit cost of S.E. Its S.E. production per acre compares favourably with that of other roots, while its P.E. yield per acre is much superior to that of roots proper. Compared with the remainder of bulky foods, it requires only from one-third to one-quarter of the acreage to produce the same amount of nutrients. Owing to its comparatively high nutritive ratio, its utility for rationing is high. Although it has the drawback of seasonal availability, it can be utilized for as long as two-thirds of the hand-feeding season. Its relative advantage, both in the economies of cost and of scale, over the whole range of bulky foods, is of a magnitude that would make it highly profitable to ensile for use at any time in a season.

The second section of Table 1 shows unit costs of protein to be considerably higher in the concentrates group of home-grown foods. It has been indicated earlier in this article that the more concentrated the food and the narrower its nutritive ratio, the lower the proportion of the S.E. part of the concentrated food that can be substituted by a bulky fodder. Unless the original method be adjusted for a better assessment of the notional unit cost of P.E. in the concentrates group, the validity of these costs would be only marginal.

It seems logical that, if the calculated cost of P.E. in the concentrates group is much in excess of that in the group of bulky foods, while the unit cost of S.E. in both groups is assumed to be equal, the implication is that both nutrient constituents in the higher unit-cost groups should be higher in cost than those in the lower-cost group. It follows, therefore, that, in Table 1, too low a unit cost is apportioned to S.E. in home-grown concentrates with the corollary of too high a unit cost of P.E.

Unit Value : Protein to Starch In line with the original argument, the unit cost of P.E. may again be determined by establishing the unit cost of S.E. in a home-grown concentrate that can be substituted for the S.E. fraction in other concentrates, up to a marginal level in which its P.E. fraction would have to be balanced. Oats appear to fulfil best the condition for such a substitution, being generally available, and having a wide nutritive ratio. Having assessed the unit cost of S.E. and arrived at the notional cost of P.E. in a number of other foods with a wide nutritive ratio, it is possible to assess from them the ratio of unit value of P.E. to that of S.E. Seeds hay is found to have a nutritive ratio comparable to that of oats, and

it is therefore assumed that the " Comparable P.E./S.E. Cost " ratio, according to the given data, will be equal in oats to that in seeds hay, namely $\frac{0.231}{0.147}$

Therefore the " Substitution Unit Cost " of S.E. in oats will be :

$$\text{S.S.E.} = \frac{\text{Cost per ton of oats}}{\text{S.E.} + (\text{P.E.} \times \text{Comparable P.E./S.E. Cost Ratio})}$$

$$= \frac{\text{£19 2s. 11}\tfrac{3}{4}\text{d.}}{59.5 + (7.6 \times 1.571)} = \text{4s. 11}\tfrac{1}{4}\text{d.}$$

Table 2 gives the corrected notional unit cost of P.E. for home-grown concentrates and for dairy cake calculated on the above substitution unit cost of S.E.

Table 2

Concentrates
Corrected Unit Cost of Protein Equivalent
(Based on oats)

Crop	Cost per ton	Starch Equivalent		Protein Equivalent			
		of Crop	Total Notional Cost	of Crop	Total Notional Cost	Notional Unit Cost	Cost per cwt.
	£ s. d.	%	£ s. d.	%	£ s. d.	£ s. d.	£ s. d.
Beans	23 0 0	65.8	16 5 1	19.7	6 14 11	6 10	1 14 2
Oats	14 2 11	59.5	14 13 11	7.6	4 9 0	11 9	2 18 7
Dredge corn ..	23 0 0	52.9	16 1 1	10.0	6 16 3	13 8	3 8 1
Dried grass (17% C.P.)	22 17 4	65.0	13 1 4	11.2	9 18 8	17 9	4 8 8
Dried grass (13% C.P.)	21 10 0	49.4	12 4 0	7.3	9 6 0	1 5 6	6 7 5
Dairy cake ..	35 0 0	60.0	14 16 5	13.2	20 3 8	1 10 4	7 11 8

The unit cost of P.E. is lower in the group of home-grown grains from that in dried grass and dairy cake, and lowest of all in beans. The last-named has two additional advantages. Firstly, it has a high protein concentration, having a nutritive ratio of 1 : 2 against 1 : 7 of oats and 1 : 6 in dredge corn with 20 per cent pulses. It thus has a very high value for balancing rations deficient in protein. Secondly, a 15-cwt. crop of beans will yield 331 lb. P.E. per acre, about double that of a 1-ton crop of oats (170 lb. P.E. per acre) and about one and a half times that of a 1-ton crop of dredge corn (224 lb. P.E. per acre) with only a slightly lower yield of S.E. than that of the white crops in question.

High protein dried grass has a nutritive ratio of approximately 1 : 3.5, similar to that of dairy cake, although at a level of nutrient concentration about 15 per cent lower. It is therefore suitable for substitution for dairy cake up to a narrow margin of feeding, practically limited to highest yielding cows. At the current price of dairy cake,* high-grade home-grown dried grass has a considerable economic advantage over purchased cake and is also more readily available. Its advantage over home-grown grains lies in

* No account has been taken of the manurial residue value of cake, therefore the calculated unit cost of P.E. is slightly biased on the higher side.

Table 3

Yield per Acre of Crops and Nutrients and Summary of Tables 1 and 2

Crop	Nutritive Value S.E.	Nutritive Value P.E.	Approx. Nutritive Ratio 1 :	Yield per Acre Crop	Yield per Acre S.E.	Yield per Acre P.E.	Cost of Crop per ton	Notional Cost Per Unit S.E.	Notional Cost Per Unit P.E.	Notional Cost Per cwt. P.E.
	per cent	*per cent*		*tons*	*lb.*	*lb.*	£ *s. d.*	*s. d.*	£ *s. d.*	£ *s. d.*
Meadow hay	32.0	3.2	11	1.3	932	93	4 16 10	2 11	2 9	13 8
Kale (Thousandhead) ..	10.3	1.5	5.7	18.0	4153	605	1 16 10	3 2	3 2	15 7
Seeds hay	37.0	4.6	6	1.4	1160	144	6 10 0	2 11	4 8	1 3 1
Oat straw	20.0	0.9	39	0.8	358	16	3 3 10	2 11	5 7	1 7 11
Grass silage	12.6	1.7	5.4	3.5	988	134	2 10 8	2 11	8 0	1 19 10
Arable silage (oat and vetch)	12.8	1.6	7	6.0	1720	215	2 11 7	2 11	8 9	2 3 11
Swedes	7.3	0.7	7	17.0	2780	267	1 15 2	2 11	19 7	4 17 11
Mangolds	6.5	0.4	13.5	30.0	4368	269	1 9 0	2 11	1 4 11	6 4 6
Cabbage (Drumhead) ..	6.6	0.9	6	20.5	3031	413	2 3 7	2 11	1 6 10	6 14 4
Beans	65.8	19.7	2	15cwt.	1105	331	23 0 0*	4 8	6 10	1 14 2
Dried grass (17% C.P.)†	52.9†	11.2 †	4	3 tons	3562	753	23 0 0*	4 8	17 9	4 8 9
Oats	59.5	7.6	7	16 cwt.	1066	136	19 3 0	4 8	11 9	2 18 7
Dredge corn (20% beans)	65.0	10.0	6	17 cwt.	1238	190	22 17 5	4 8	13 8	3 8 2
Dried grass (13% C.P.)†	49.4†	7.3 †	6	2.5tons	2778	421	21 10 0*	4 8	1 5 6	6 7 5
Dairy cake	60.0	13.2	4	—	*per ton* 1344	*per ton* 296	35 0 0	4 8	1 10 4	7 11 8

* Estimated

† On a dry matter basis

its yield of nutrient per acre, roughly three times as high as that of grain crops. Low protein dried grass, on the other hand, while higher in unit cost of P.E., highest in fact of all home-grown foods, has a substitution utility only slightly in excess of that of oats, while the latter's unit cost of P.E. is less than half. Whether or not it has an advantage in scale of production sufficient to offset the drawback of a high unit cost of nutrient is, in Kipling's words, "another story"; so is the problem of the relationship between farm costs and scale of farming operations and the over-ruling problem of farm organization itself.

Table 3 opposite gives the yields of crops and the relevant yields of nutrients per acre and summarizes the data discussed in this article, which is based upon material being prepared for a bulletin to be published by the University.

THE CONTROL OF SOME PERENNIAL WEEDS IN PERMANENT GRASSLAND BY SELECTIVE HERBICIDES

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Since 1943 a number of experiments have been carried out to test the effect of selective herbicides on the more common perennial weeds such as buttercups, thistles, ragwort and rushes. The quantity of herbicide required and the correct time for treatment vary with species, so no general recommendation is possible, but it is obvious that, without careful management to encourage the vigorous growth of grasses and clovers on patches left after successful weed-killing, there is a serious danger of reinfestation.

THE first evidence that synthetic growth regulators could kill selectively perennial weeds in grassland came from the initial experiment laid down on a Hertfordshire water-meadow in the autumn of 1943. There, by the following spring, it was found that the meadow buttercup (*Ranunculus acris*) had been largely eliminated by the sodium salt of MCPA (2-methyl-4-chlorophenoxyacetic acid). On the other hand, the most effective concentrations had to some extent depressed the clovers which, however, recovered as a result of close grazing. From these results it was therefore apparent that the further development of this new type of herbicide would involve taking into account the factors of legume susceptibility and grassland management. It also followed that there was the further problem of preventing a reinfestation once the weeds had been destroyed. Clearly, the rate of reinvasion would be linked with the degree of the original infestation, and without an attempt being made to rectify the conditions which favoured the weeds, a single treatment with herbicides would not maintain the sward weed-free.

Since 1943 a large number of multifactorial experiments have been carried out on grassland, and the results have served to stress that herbicidal treatment cannot be divorced from management. The importance of drainage,

alone. To illustrate this type of experiment, the results of one trial are given in Table 1. These figures emphasize also the point already made that increasing the amount applied beyond a certain level does not further increase the degree of control.

Table 1

Percentage Reduction in Shoots of Creeping Thistle in the Year following Treatment

Dose of MCPA (applied as Sodium Salt)	Sprayed July 1 (Bud Stage)	Mown June 30 Sprayed July 1 (Bud Stage)	Mown June 30 Sprayed September 24 (Regenerating Shoots up to 9 inches high)
lb. per acre			
0	0	60	60
0.43	68 (14.6)	74 (13.4)	66 (15.5)
0.66	65 (16.2)	70 (14.0)	69 (15.2)
0.99	96 (5.7)	71 (11.8)	83 (10.4)
1.53	96 (5.4)	83 (7.9)	81 (12.1)
2.28	87 (9.2)	74 (12.2)	87 (10.2)
3.46	97 (4.5)	92 (8.0)	74 (13.4)

Figures in brackets are square root transformations of the shoot density to which a significant difference ($P = 0.05$) of 2.5 is applicable.

Apart from creeping thistle, individual trials have been carried out on spear thistle (*Cirsium vulgare*) and marsh thistle (*Cirsium palustre*), and the results demonstrate that these two species can readily be controlled with MCPA and 2–4D at the rates recommended for creeping thistle. On the other hand, the ground thistle (*Cirsium acaulae*) is resistant.

Ragwort Although about eighteen experiments have been undertaken, it is still not possible to give firm recommendations for the control of ragwort (*Senecio jacobaea*) by herbicides. One difficulty is in assessing the effects of the treatments because of the life history of this weed. The seed germinates in the autumn, winter, and early spring and the seedlings pass the ensuing summer as vegetative rosettes. On waste ground these plants would flower, fruit and die in the following year, but under conditions of grazing and trampling many plants do not flower in the second year but persist in the sward, thus behaving as perennials. If the shoot is severely damaged, regeneration can still take place from root fragments and such regenerating plants often superficially resemble seedlings. In consequence, when the experiment is examined the year after spraying, it is often difficult to determine the age of the rosette and flowering plants, or to distinguish rosettes from seedlings which have arisen from seed blown in from outside the trial area. In some experiments a further complexity has arisen which has made nonsense of the results : during the winter the whole ragwort population can virtually vanish, even when the original population consisted of both rosette and flowering plants. This so far inexplicable disappearance has been observed not only on control plots but also on a field scale.

Despite this difficulty, it is possible to indicate the treatments which are most likely to prove effective. In the first place, 2–4D has generally given a better kill than MCPA, although the difference has often been small. On the average, a dose of 2 lb. per acre has resulted in a fair measure of control—but 4 lb. is better. This improved kill has to be set, however, against the higher cost and the increased risk of depressing any legumes present in the sward. The best time to spray appears to be in June, when the flowering shoot is developing rapidly but before the buds are showing signs of opening :

some equally good results have been obtained in the spring but June is preferable. Even so the June treatment, although it may prevent the formation of viable seed, is not infallible ; in fact, individual cases have been observed where for no apparent reason it has failed to prevent flowering in the same year. Contrary to expectation, ragwort seedlings have proved to be as difficult to kill as plants in their second year.

From what has been stated, it will be apparent that a single treatment will rarely eradicate ragwort from a pasture. Eradication will almost certainly demand spraying in at least two consecutive years. It is not yet known whether low volume spraying can effectively replace the high volume applications employed in these trials.

In the past, particularly in New Zealand, sodium chlorate has been used for the selective control of ragwort in grassland, and in many of our experiments sodium chlorate was compared with the growth-regulating substances. Applications at the rate of 30-50 lb. per acre generally killed most of the ragwort plants but at the same time the grasses were considerably injured. Besides bare patches this injury resulted in a thin open sward and, in consequence, the area was reinvaded by seed coming from adjacent areas. Thus in general, MCPA and 2–4D have advantages over sodium chlorate.

Common Rush As a result of the reports received from various sources that rushes could be controlled with plant growth regulators, experiments were started in 1950. There are many species of rush which occur in Great Britain and to the layman they are difficult to distinguish, but the common rushes (*Juncus effusus* and *J. conglomeratus*) are the most frequent constituents of wet grassland in England and Wales. So far, it has been found that *J. effusus* is easily killed by both MCPA and 2–4D, the compounds being approximately equal in effectiveness. To ensure a good control, 2 lb. per acre should be applied slightly before or at the flowering stage. Contrary to general opinion, mowing the rushes immediately before spraying did not improve the degree of control—rather, it depressed it. This evidence is based on a single experiment and requires confirmation. In addition, there are as yet no detailed results for the effects of other possible combinations of cutting and spraying. Nor is it known whether other rushes will react differently.

The weed species so far discussed show a wide range of susceptibility to the plant growth regulators, and this variability is shared by other perennial weeds of grassland. Ribwort (*Plantago lanceolata*) can be classed with creeping buttercup ; the daisy (*Bellis perennis*) and the dandelion (*Taraxacum officinale*) can be placed in the same category as meadow buttercup. But, with the dandelion, 2-4D is more effective than MCPA for a late application. Yarrow (*Achillea millefolium*), marsh horsetail (*Equisetum palustre*) and established plants of broad-leaved docks (*Rumex obtusifolius*) cannot readily be controlled. Three detailed experiments on marsh horsetail have been carried out in which MCPA, 2-4D and 2, 4, 5-trichlorophenoxy-acetic acid (TCPA) were applied as the sodium, amine and ester formulations. The results showed that although these treatments killed the shoots they failed to have any permanent effect as measured by counts in the following year. Lastly, bracken (*Pteridium aquilinum*) has proved to be wholly resistant. Thus the present growth regulators do not constitute a sovereign remedy for ridding grassland of perennial weeds ; rather, they should be regarded as new ingredients for the general prescription of good management.

The authors wish to thank all those farmers who allowed experiments to be carried out on their land. They are also indebted to many members of the National Agricultural Advisory Service for their willing co-operation.

Wolf of the Willow

MANY a Kentish Lane owes its character to the red brick hop kilns which stand like miniature medieval strongpoints sentinel to the quiet countryside beyond. Of all farming activities none is so clearly advertised to the casual eye as hop growing, and the association of Kent and the English hop is one honoured by custom and hallowed by time. Early in the sixteenth century cultivated hops were being brought from Flanders and established in south-east England, although wild hops were growing here so profusely as to earn for themselves the sobriquet of " this wicked weed " in a petition against their culture which it is alleged was presented to Parliament in Henry VI's reign. Its botanical name, *Humulus lupulus*, recalls that the latter word is an abbreviation of *lupus salictarius*, meaning " wolf of the willow "—from its habit, as Pliny tells us, of twining around and choking the willows among which it grew and so proving " as destructive as a wolf to a flock".

Be that as it may, the English variety of the cultivated hop quickly gained a high reputation, for, as Leonard Mascall wrote, " One pound of our Hoppe dryed and ordered will go as far as two pounds of the beste Hoppe that cometh from beyond seas". Hop gardens spread widely as beer challenged ale as the popular national beverage. Generally speaking, the crop was a profitable one, as Arthur Young noticed in the Farnham district : " . . . Hop grounds let here from £3 to £9 an acre, which last price is very great. The labour attending them they reckon £3 10s. an acre per ann. The poles cost (according to their hyth) from 12s. to 22s. a hundred ; last 4 or 6 years and 2,600 required to the acre. They consider 12 cwt. a middling crop and the average price at £6 or £7 per cwt., which circumstances prove the improvement of this culture." Labour for picking was also cheap, and, as Bannister records, was generally made up of " women from the poorest classes," who received 1d. or 1½d. a bushel—plus, apparently, a daily morning dram of Geneva gin to get them off to a good start !

By the beginning of the nineteenth century about 35,000 acres were under hops ; by 1850, between 40,000 and 50,000 ; and, by 1878, the peak year for hop growing in this country, just on 72,000 acres. As many as fifty three counties in Britain were growing the crop at this time ; 40 in England, 8 in Wales, and 5 in Scotland. But in point of fact, not more than about 500 acres of the 72,000 were outside the six main hop-growing counties of Kent, Sussex, Surrey, Hampshire, Hereford, and Worcester.

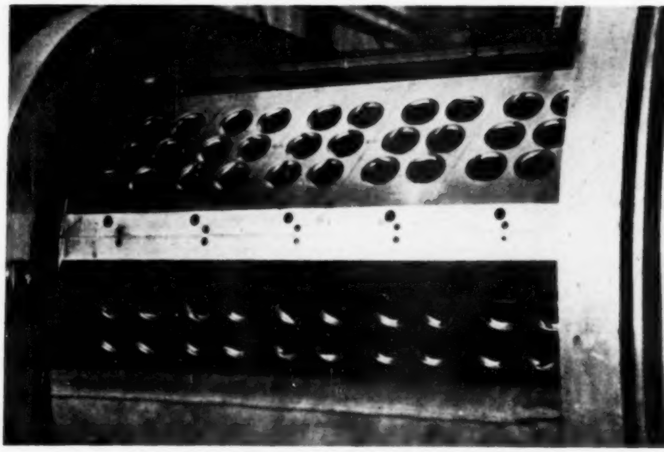
Today, three-quarters of a century later, hops are still an important home crop, and Kent is still its stronghold, although the "yards" of Hereford and Worcester have special claims to distinction. The total area is much smaller—some 22,000 acres—reflecting the changes in economic circumstances, social habits and public taste. Cultivation and general management have made marked advances, plant breeders have given us better varieties, and on many hop farms austerely modern and highly efficient oast houses have replaced their picturesque predecessors. Although some of the old kilns are now used only as store-houses—and some even adapted for human habitation—not a few have been re-equipped and are still giving good service.

S.R.O'H.


Photo: ***P. W. Lang***

Oast house in a Kentish lane ; now, with its white cowls removed, used as a store

THE MECHANIZATION OF HOP PICKING (See pp. 25-9)



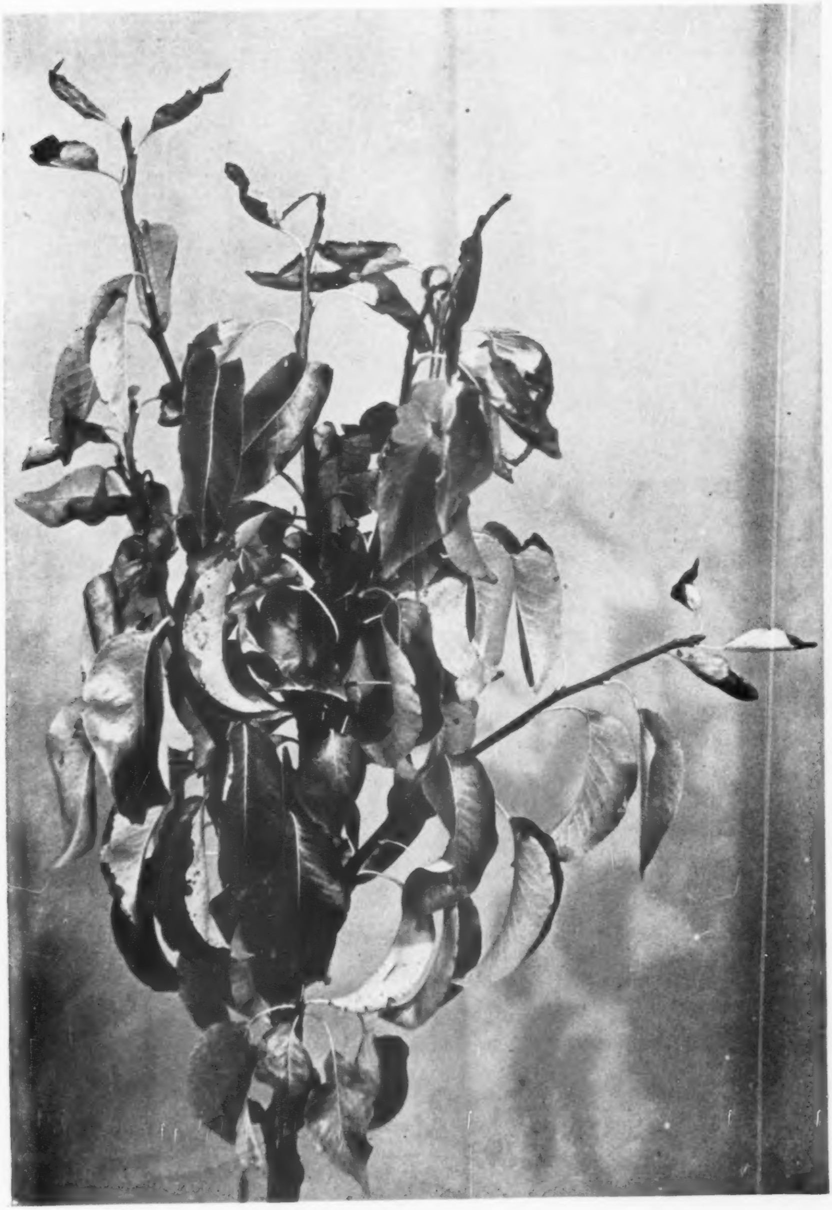
An experimental plucking machine. The bine is drawn over the rotating drum, the hops being sucked through the cutting orifices and the stalks severed by circular knives

Photos: *J. A. C. Gibb*

Left : The spring-mounted combs of a plucker-bank machine.

Right : A typical hop-picking machine showing the rear end of the lateral picker (A), the two stages of "petal" and "seed" separation (B), the leaf separator (C), the inspection and hand-cleaning conveyors (D) and the conveyor carrying away the leaves (E)

COPPER DEFICIENCY IN PEARS (See pp. 35-7)



Wither - Tip

COPPER DEFICIENCY IN PEARS (See pp. 35-7)

The rough, scaly bark of a pear tree suffering from copper deficiency

Left : Pear tree sprayed with 0.075 per cent copper sulphate solution
Right : Untreated tree showing severe symptoms of copper deficiency

THE MECHANIZATION OF HOP PICKING

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Scarcity and the rising cost of casual labour for picking hops by hand is attracting attention to mechanical pickers. The need for them and their present possibilities is discussed by two writers who have made a special study of the problem.

TRADITIONAL methods of growing hops have always involved a large amount of manual labour, and this labour demand works up to a climax in the month of September when picking takes place. As the labour demand increases through the season, so the casual labour force has to be increased to meet it, and at picking time the great bulk of the work is carried out by casual labour imported into Kent, Sussex and West Midlands from neighbouring large industrial areas. Hop pickers are housed by families in tented camps or in specially erected huts which may have other farm uses during the rest of the year, and for many years hop picking has been the annual paid holiday in the country for many who might otherwise have had no holiday at all. Hence, until recent years, there has been no scarcity of hop pickers, and many families have been picking hops for individual growers for unbroken periods of fifty and sixty years. Now, however, changes in social legislation and general living conditions are taking effect, and hop pickers are less easy to find. This is particularly evident in the West Midlands, which draws its supply from the Black Country towns and from some of the Welsh industrial areas, and it is also beginning to be apparent in Kent and Sussex.

Therefore, with higher wages in industry, holidays with pay, difficulties over the absence of children from school during the latter part of the hop-picking season, and the higher standards of accommodation that pickers now expect, the growers' difficulties have so increased that hand picking must give way to mechanical harvesting. Another, though at the moment less important, objective, is to lower the cost of picking.

Machines to pick hops, which in doing so enable growers to dispense with most, if not all, of the casual labour force, are thus coming to the fore. Something of the order of 50 hop-picking machines are now installed on hop farms in Great Britain, and between them pick a little under 10 per cent of the crop. By comparison, in the U.S.A. 85 per cent of the hop crop is picked by machines. The great majority of American hops are, however, much tougher than the British varieties commonly grown, and so are much easier to pick by machine without excessive shattering of the hop cones.

Machines have been in use commercially in England since 1934, when one machine was installed in the West Midlands, and it is in that area that most of the machines are now situated, largely because it is there that the problem of obtaining casual labour is most pressing. The machines in commercial use at the present time are all stationary, housed in Dutch barn types of buildings near the hop-drying kilns. The bines, when ready for picking, are cut from their rootstocks in the hop gardens at a height of about 4 feet above the ground, then cut or pulled from the wirework above and carried on trailers to the picking machines. There they are loaded, one or

more bines at a time, on to a conveyor carrying them inverted into the picking mechanism.

In America a mobile machine is also in production. This is towed by a tractor between the rows of hops, the bines being severed in the same way and picked by machine. In Britain a prototype mobile machine has been demonstrated, working in the rather narrower alleys (6½ feet wide) common in Kent. Severing the bines from their rootstocks is thought likely to reduce yields if continued over a number of years, and with the British prototype machine this is not necessary. Experimental evidence on the effect of cutting the bines is not conclusive, although it seems clear that the subsequent yield has been reduced in some cases, particularly where the bines have been severed before the hops were fully ripe, as is bound to happen to some extent in the first weeks of picking.

Types of Picking Machines All the machines in use at present follow the same general sequence of operations :

1. Pluck hop cones and some rubbish from the inverted bine.
2. Pluck hop cones from any lateral branches broken off from the main bine in its passage through the machine.
3. Separate out mechanically any small pieces of shattered hop, such as detached "petals" and "seed," from the main stream of plucked material. These rejoin the rubbish-free hop sample at a later stage.
4. Separate out pneumatically leaves from hop cones.
5. Remove mechanically small pieces of stem, leaf petiole, etc., from hop sample.
6. Pass the machine-cleaned sample over an inspection conveyor, where any extraneous matter that has escaped the mechanical separators can be removed by hand.
7. Convey the hops with shattered cones and seed added, to bagging-off point.

The plucking mechanism is the point at which the different designs of machine show the greatest variation, although the cleaning stages differ in detail. Three main types of plucking mechanism are found on present-day British machines. The original type, which is also the most gentle in its action, consists of a series of endless conveyors carrying spring-mounted combs which are drawn downwards against the inverted hop bine as it moves horizontally along, and these pluck off the majority of the cones. There are usually four banks of plucking combs, moving at increasing speeds, so that the severity of treatment is increased as the bine passes farther into the machine. Even so, it is rare for all the hops to be picked on the plucker banks, and so a further mechanism is required to pick the remaining 10–30 per cent of hops. This is a device, similar in some respects to a hammer mill, consisting of two parallel shafts rotating in opposite directions, on which are mounted a number of discs. The discs carry pivoted on them a series of fingers or hammers which are thrown outwards by centrifugal force as the shafts rotate and strike off hops and a certain amount of leaf and stem as the bine is drawn between the two shafts. The severity of treatment can be adjusted by increasing or decreasing the speed of rotation.

The second type is simply a modification of the flying fingers just described, but on a slightly larger scale. This dispenses with the complex, bulky and expensive plucker banks, but the hops are necessarily picked more roughly and so it is often found that the amount of breakage experienced is rather high.

The third type deals more gently with the hops than the flying fingers, and consists of two contra-rotating cylinders each bearing a number of spring-steel tines so arranged that as the cylinders rotate the tines also move round, but are carried always in the same plane. Thus the hops are subjected to a pull which is constant in direction—either directly downwards, or at a small angle, depending on the type of machine—and which is cushioned by the spring in the tines. The inverted bine is passed between the cylinders, suspended from a sloping conveyor so that the head of the bine—nearest the ground—is picked first, and the last part to be picked is close to the hook suspending the bine from the conveyor. Here again the severity of treatment depends on the speed of rotation.

The lateral-picking mechanism consists of a roller conveyor, having groups of three rollers mounted immediately above the conveyor rollers at intervals along its length. The first roller of each group is driven at the same speed as the conveyor rollers, while the other two, with the conveyor rollers beneath them, are driven faster. The relatively long lateral bine is held back by the slow-moving pair, and the faster-moving rollers pluck at the hop cones and pick most of them. In one design all the rollers are covered with soft rubber ; in others only the plucking rollers are so treated. The lateral bines are lifted out of the stream of material picked by the main plucking mechanism and carried up to the lateral picker by a tined conveyor. The hops picked by the lateral picker fall through the spaces between the conveyor rollers and rejoin the rest of the hops travelling below.

Separation of the seed and "petal" from the hops occurs next, by using either a wire mesh conveyor or a roller conveyor as a sieve. Any very small pieces of leaf and stem will also pass through, but not normally in sufficient quantity to be serious.

For removing leaf from the hop cones, in the next stage of separation, use is made of the greater effect of suction on flat leaves than on round cones, and the leaves are sucked away from the hops either as they pass along a wire mesh conveyor or as they are projected from the end of a conveyor. The leaves are released from the airstream by passing them over a surface not subjected to suction, and are then discharged to waste.

Rate of Working The output of hop-picking machines is best measured in terms of the quantity of dried hops obtained per working hour, as the measurement of green hops is subject to considerable inaccuracy due both to variation in moisture content and to human error. Generally speaking, high output of hops depends on the weight of hops per bine and on maintaining a constant and even feed of bines into the picking machine. It is possible, however, to obtain a high output figure at the expense of a high rubbish content of the final sample, as well as a large proportion of broken hop. Data collected in the last three seasons (1) have shown samples containing from 2 to 20 per cent of rubbish, and whole hop contents varying from 25 to 70 per cent. These proportions are by weight, and the fairly exacting standard set defines a whole hop as a hop cone from which not more than two petals appear to have been detached. The output varied over the group of machines observed from 1½ to 3 cwt. of dried hops picked per hour, and the labour requirement of the machines was from 15 to 35 persons. In addition, about a dozen workers and two or more tractors are required in the hop garden, so that the total labour force may be from 25 to 40 persons, of whom the majority will be unskilled. The labour involved in picking hops by hand varies from 1,000 to 1,200 man-hours per acre, assuming a crop of 16 cwt. of dried hop to the acre. Under these conditions

a machine would pick from 1 to 2 acres per day, while hand picking would require 100 to 200 workers. The standard of hand picking is at present higher than that of machine picking, and the sample averages 70 to 80 per cent of whole hop and about 5 per cent of rubbish, the remainder being partly-broken cones. Good machine picking approaches these figures, but the average at the present time is probably nearer 50 per cent of whole hop and 10 per cent of rubbish.

Future Possibilities Besides the machines already described, there are other types in the prototype and development stages. The mobile machine already referred to plucks hops by wire loops or combs, which is a form of mechanism basically similar to that used widely in America. The loops are mounted on a pair of conveyors, which travel horizontally along the sides of a bed in which the hop bine is laid as the machine moves from hill to hill through the alleys in the hop garden. They strip the hop cones and some rubbish from the bines, which are then pulled out and dropped back on the soil without being severed from the rootstock. The sample is cleaned by conventional means elsewhere on the machine before the hops are bagged off.

Although the output is not as high as that of most stationary machines, such a mobile machine should be a good deal cheaper than a stationary one, and in addition it does not require to be housed in a large and expensive building. There may also be a future for a simple mobile plucking machine which does not attempt to separate the rubbish from the sample in the garden, but relies on orthodox machinery in a building near the kilns for such cleaning. A machine of this type might be smaller and cheaper than the complete picker-cleaner and might have a higher output.

A stationary machine designed on completely different lines from all those mentioned above is also in the prototype stage, and this cuts the hops from their stalks by a number of circular knives mounted peripherally on revolving drums or "tubes". The hops are sucked into the knife orifices and their stalks are pressed against the cutting surfaces by rotating guides. The severed hops are then carried pneumatically to a simple leaf extractor, which also releases them from the airstream, and they are there sacked off. It is possible that samples which are both more whole and cleaner than hand-picked hops may be produced by this machine, although some problems still remain to be solved before it can be put into commercial production.

The Productivity Team recently sent to America to study the hop industry there, formed the opinion ([2]) that the American machines in their present forms would be unlikely to pick British hops as well as the existing machines in this country, and this view has been borne out by the results obtained from the one or two standard American machines imported by a private firm.

Hop-picking machines of all types are very expensive at present, and the rate of depreciation, and possibly also of obsolescence, is high. Provided a machine picks a reasonably large acreage each year, it is probably no more expensive to pick by machine than by hand, and may well be cheaper. Some growers owning machines have been able to pick hops for neighbours within easy carting distance after completing their own hop picking, and have thus been able to extend the effective acreage and spread their costs. It is unlikely that contract picking can ever be much more than an emergency measure, however, due to the importance of picking the crop as soon as it is ready.

It is reasonable to predict that the number of machines installed will increase rapidly for the next few years on the larger hop acreages—say 20 acres and over. With machines built on the present scale, though, it seems unlikely that the smaller growers would be able to justify the capital outlay, and so it is doubtful whether hop picking is ever likely to be completely mechanized, unless a really small and cheap plucking unit can be designed.

References

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ENSILAGE IN THE WEST MIDLANDS

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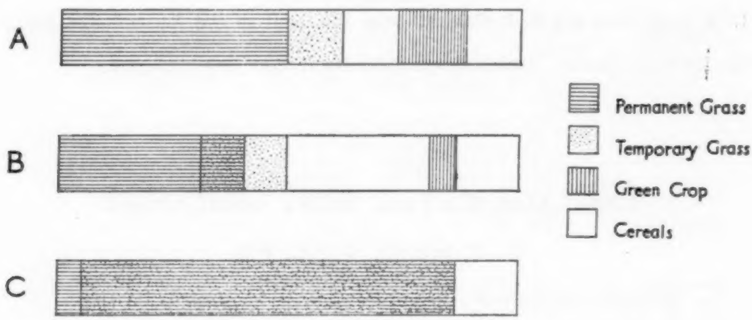
With the advent of the pit silo, the buckrake and other forms of mechanical loader, the practice of ensilage has acquired a new lease of life. It offers a first-rate method of preserving high protein fodder and can set up a chain reaction leading to higher output. In the West Midlands, ensilage has developed greatly, though erratically, in the past few years ; the following article, compiled after an extensive inquiry by county and district officers is therefore in the nature of a progress report.

EVER since farms were enclosed, custom and tenancy agreements have decreed that they should be divided into two sections—permanent grass, the property of the owner, and rotation land or "arable," the latter often carrying for varying periods clover or temporary grass, the property of the tenant (see Fig. A, p. 30).

The increase in the number of owner-occupiers, progress in the technique of grass husbandry, and the need for self-sufficiency, have together broken down the rigid distinction between permanent and temporary grass. Rotations have become much more flexible. It is no longer necessary to restrict cultivation to the arable part of the farm; nor, thanks to the power and speed of tractors, is it necessary to adopt fixed rotations including fallow crops: the worth of these latter crops must be judged on their merits.

Practically everyone recognizes that temporary grass is more adaptable and productive, or at any rate can be made more productive, than permanent grass. Furthermore, temporary grass is easy to establish, hence it can be punished, at least in its last year, without dire consequences; it can be forced, overgrazed, and even poached, if necessary; when it has served its purpose, it can be ploughed without fears or tears. While special-purpose leys seem the ideal, it is not absolutely essential to decide before the seed is sown how the crop is going to be used, nor even how long the ley is to remain down. On difficult fields, the farmer can sow a mixture which, if well treated, will last indefinitely, but he is still free to plough it up at any time. Three types of grass thus come into existence—permanent grass, temporary grass and "permanent temporary" grass. Many a Midland farm can be represented diagrammatically as Fig. B.

On farms where the plough can be kept moving, this process may be carried to its logical conclusion. The whole farm may be seeded down; each year, a certain area is ploughed out for cropping with cereals for a few years before going back to grass. From time to time, a field may be ploughed out and reseeded on the upturned sod. Usually, a paddock or two is kept in permanent grass and the farm becomes as shown by Fig. C.



Since the purpose of many farms, apart from cash crops, is the production of keep for stock, the proof of this particular pudding must lie in the eating. Whether or not the system constitutes good husbandry must be judged, in the first place, by reference to the stock kept.

The Case for Grass Ensilage About a third of our total grassland is dried for hay, and the bulk of the nutrients fed to cattle in winter is supplied in this form. Haymaking is a very wasteful process involving a loss of anything from one-third to one-half of the nutrients in the green grass: the annual loss to the country must amount, therefore, to some 1½ million tons of starch equivalent—equivalent, that is to the total loss of our oat crop.

Many reasons can be found, of course, to excuse if not to justify this appalling loss. Haymaking is a quick way of dealing with large acreages—or at least everyone starts off the harvest in that hope! It requires relatively little labour; there are numerous machines to deal with it, though the cry of "owd yer" is still heard in the land. Hay is easy to store, light and easy to transport. But the basic reasons for our conservatism lie in ourselves. The losses are hidden, nobody is much concerned about unseen losses. We do not miss what we have never had. And, haymaking is something more than a farm operation: it is a solemn rite, a burnt sacrifice offered on the altar of tradition. The hay harvest is an institution as deeply embedded in the rural conscience as the Wakes: movable, like Easter, but a definite point in the season's calendar.

The loss of nutrients can be reduced by improved haymaking methods, but if modern techniques are to be turned to full account and the best use made of land, an alternative method of preserving grass must be employed. Ensilage entails much smaller losses, although the practice grows but slowly. In 1950, some 6 or 7 million tons of hay were made; the equivalent weight preserved as silage was not more than ¼ million tons, so it will be seen that less than 5 per cent of the country's grass is at present ensiled.

On Dairy Farms It is on dairy farms that ensilage makes the greatest appeal. In South Cheshire, North Shropshire and central Staffordshire, where climate, flat land and retentive soils combine to make root growing difficult, and even cereal growing is carried on in constant fear of sticky seedbeds and draggling harvests, a great deal of silage is now made. Ensilage offers a justification for intensive management of grass, avoids the risks of the hay harvest and provides a protein-rich fodder, thus lessening the need for purchased concentrates.

Ensilage can be practised economically on any farm large enough to carry a suitable tractor. Its extent depends more on the layout of the farm, and the proportion of land really suitable for intensive treatment, than on equipment. And the fact that it can be carried on without overtime work—except perhaps in May—is a distinct advantage. Early experience showed that, although some very high-grade silage (over 18 per cent crude protein (C.P.)) can be produced on any farm, it is scarcely practicable to provide fully for winter's needs with material of this grade. It is prudent to plan, instead, for a larger quantity of material of high and medium grade (around 15 per cent C.P.*). Though the period of full winter rations in the West Midlands is often reduced by kale feeding in the autumn and early bite in the spring to about 5 months, it is safer to calculate on winters of 180 days.

The farmer has various methods of using silage, according to the scale on which it is fed. For example, it can be used at 60 lb. per day as a maintenance (M) + ½ gallon ration, in which case 3½ tons will be required for a full winter; or as a M + 1 gallon ration, when 70 lb. per day (or 5 tons per winter) will be required. A third, and probably the commonest, method is to use it as the major part of a M + 1 gallon ration, together with a small allowance of hay, dried grass or oats. Many farmers now aim at an output of three or four tons per cow-equivalent (C.E.) To achieve this on a heavily stocked farm, it is necessary to rely largely on leys and to work them hard, to manure freely and to cut two or three times a year.

Four farms, believed to be typical of those which have turned seriously to silage-making, showed the following averages per 100 acres for 1950-51:

CROPS (acres)

Permanent Grassland	Temporary Grassland	Arable Silage	Fodder Corn	Wheat
57	29	4	7	3

FERTILIZERS APPLIED (cwt.)

Complete	"Nitro-Chalk"	Supers	Farmyard Manure
203	174	65	6,200

WINTER PRODUCE (tons)

Silage	Hay	Dried Grass	Corn
184	22	4	9

The average stock per 100 acres was 57 C.E.

These figures leave no room for doubt as to the intensity of management which has developed with silage-making, although at first glance it seems inconsistent that 57 per cent of the land remains under permanent grass. It must, however, be realized that on these farms only a limited area is really suited by soil conditions and access to intensive treatment. In a sense,

* In 1950, 1,000 samples examined at the W. Midland N.A.A.S. Provincial Centre were graded into the following groups : Very high, 10 per cent ; High, 30 per cent ; Medium, 30 per cent ; Low, 30 per cent.

heavy stocking on farms such as these may be said to bring its own reward, since it makes available very large quantities of farmyard manure. It is noteworthy, however, that these dressings were supplemented by 2 cwt. per acre complete fertilizer and 2 cwt. per acre "Nitro-Chalk".

By no means all the land in this area is heavy. On light and medium soils, cash crops naturally feature more prominently, but 4 tons of silage per cow—a "ton a leg" to quote the phrase which has come into common use—is often aimed at. Four typical cases investigated show the average records per 100 acres as:

Permanent Grassland	Temporary Grassland	Arable Silage	Arable Fodder	Cash Crops	Silage (tons)	Cow Equivalents
15	41	10	17	17	210	41

As a rule, the ley, managed on the same principles as on heavier land, furnishes most of the silage material, though some leys are cut early and bastard- or "pin"-fallowed for wheat. Winter oats and vetches are similarly cut early to be followed by a green crop: arable silage mixtures are commoner, partly because of their value as a nurse crop for seeds. On some farms, kale and rape are sown with spring cereals, and, after harvest, allowed to grow for silage-making in November. Kale itself is frequently ensiled, as also are beet tops.

In extreme cases, the bulk of the farm is in ley. Thus one farm in the Lichfield area consists, per 100 acres, of 6 acres permanent grassland, 8 of oats, and 84 of ley. As a rule, only one crop of oats is taken from a field before it is reseeded. The total production of silage now amounts to 300 tons, or roughly 5½ tons per cow-equivalent.

Production and Storage Though most farmers rely on leys for the bulk of their silage, there is much variation both in the seeds mixtures used and in the system of treatment. Ryegrass mixtures, mixtures of Cockle Park type, fescue-timothy mixture, and straight seedings of Italian ryegrass are all sown. Treatment tends to be opportunist, any or all of the following systems occurring on different fields on the same farm: silage–hay–graze; graze–hay–silage; silage–silage–graze.

On the average, probably six cuts for silage or hay are taken in three years. The bulk of the material for ensilage is inevitably obtained in May and June, with a smaller flush in late August and September. Cocksfoot-timothy leys help to fill the July gap, but the best crops so far discovered for this period are oats seeded down, or the first growth of direct-seeded leys. Italian ryegrass extends the cutting season by providing material in April and early May.

Silage-making on the scale described here is, of course, a major operation of the summer. By far the commonest arrangement is to cut at the rate of about 1 acre per day (on a 100-acre farm), a tractor-driver cutting at night or in the early morning and stockmen collecting between milkings. Green-crop loaders and buckrakes share the burden; there are few cut-lift loaders.

Some storage in stack and silo is carried out, and provided the mass of material is large enough to ensure thorough consolidation, good material is obtained, with little waste. The most popular system is, however, pit storage. Here, siting of pits to avoid drainage troubles and to ensure easy cartage in winter is important. If possible, filling is begun on Friday afternoon or Saturday to allow the development of sufficient heat over the week-

end. Cartage can then proceed at full speed the following week. Nowadays, a good deal of grass is forked into the pit from vehicles drawn alongside the pit rather than over it. (There is, however, still room for improvement in tipping arrangements for trailers used in making pit silage.)

The pits are generally sealed by hand or tractor scoop with about six inches of soil. Theoretically, with pits which are in continuous use, this soil should serve to seal them for an indefinite period, but it has a curious habit of disappearing in the course of two or three years. Lime and farmyard manure are both used instead of earth, and much thought is now being given to the question of sealing the pit with waste green material only. No one has solved the problem of cheap extraction from the pit. Most of the silage is still cut out by hay-knife, and a saw-toothed type, now under trial, seems to be an improvement on traditional design.

Feeding Silage is by no means easy to ration accurately. In the first place, few farms have the facilities, and few cowmen the time needed to weigh out rations regularly. Secondly, judgment of quality is difficult. In a long series of personal tests, our officers have compared their field assessments with the results of laboratory analyses, and it has been noted that, whereas protein content can be assessed in the field with a fair degree of accuracy, field estimates of moisture content are often wide of the mark. Finally, even laboratory analyses are but a guide to quality; the crude protein figure—itself an estimate based on total nitrogen—may not wholly reflect the nutrient value; on occasion, the evidence of the cows belies that of the chemists. Cattle on a silage ration often milk better and look better than the analysis would lead one to expect. As an example, a large herd of Friesians was fed throughout last winter, and milked well, on a ration of 70 lb. medium silage, 4 lb. dried grass (18 per cent C.P.) and 2 lb. oat straw, for 2½ gallons, with strictly balanced concentrates for the heavier milkers.

On the other hand, when the matter was put to the test on four farms where, during a whole winter, more than a third of the total nutrients were supplied in the form of silage, a remarkably close correlation was obtained between the theoretical requirements of the herds and the total nutrients fed. Moreover, on three farms where silage rations supposed to supply M + 1 gallon or thereabouts were fed, the amount of concentrates used per gallon of milk worked out at 1.9, 2.7 and 2.9 lb.

Young stock on silage-making farms are naturally silage-fed, in quantities proportionate to their age. Normally, the older heifers get silage only in addition to grazing afforded by the pastures and some straw picked up in yards. A ration of 30 lb. silage with oat straw is regarded as suitable for two-year-old heifers when housed, but calves and yearlings naturally get some concentrated foods in addition. On one Staffordshire farm—and that at a high altitude—where notable success has been achieved, the heifers receive no concentrates whatsoever from six months old until they approach calving, the standard winter diet consisting of two feeds of grass silage and one feed of hay daily.

On Stock-Rearing Farms Conditions on stock-rearing farms are so different from those on dairy farms that ensilage has to be approached from a different angle. There is not the same urgency about getting returns on heavy capital outlay, for rearing farms are not as a rule heavily stocked. Their economy is more varied: cattle rearing is combined with sheep husbandry and, on lowland farms at least, cash crops generally form a major enterprise.

In upland regions, systems of management are limited by the terrain, the shortness of the grazing season, and the high rainfall. On the whole, the standard of management is lower than that on the plains, and grass crops are lighter—although, in truth, the potential of many upland regions is distinctly high. Nearly all growth is compressed into a period of about four months, but stock can remain out in winter for a longer time than on most lowland farms as the risks of poaching are much less. Production of good hay on upland farms is extremely difficult; indeed, in most seasons it is impossible except by some system of piking, cocking or the use of tripods. There are certainly many seasons in which no good hay is made at all. Yet hay has the supreme merit of lightness, and there can be no question of displacing it; the only question is how far it can be reduced. If a portion of the grass can be preserved as silage and the quantity of haymaking reduced, the chances of winning some good hay are increased.

Rearing is an empirical business in which the eye and hand replace the spring balance. Stock are fed in groups and individual rationing is impossible. Many cattle are outwintered, picking up variable but indeterminable amounts of keep from their grazing. The vague quality known as condition or "bloom" is about the only guide a farmer can have, and a good deal turns on the value attaching to it. In poor seasons, of course, the problem of bloom does not arise; in fact, the problem is the very opposite—namely, how to carry stores through the winter without letting them lose weight.

On rearing farms, therefore, silage can play a useful part; but its value is less evident than on dairy farms. Converts to ensilage are much less numerous and even where it has been absorbed into the farm routine it is practised less freely, but none the less, considerable quantities of silage are today being made on rearing farms.

As on dairy farms, leys are the main source of material. In Warwickshire, however, lucerne is coming quickly to the fore. Usually, only one field is involved; it is sown down (often with an admixture of cocksfoot or meadow fescue) in the expectation of a stand of 5 or 6 years, and when it becomes weak or foul it is ploughed up and replaced by another break. Three cuts, or two cuts and some grazing, can normally be obtained, 7–10 tons of silage per acre being an average yield.

As a winter feed for stores, silage appears to commend itself to everyone who has tried it. Practice on a number of rearing farms, mainly in Warwickshire, has been examined in some detail and experience may be summarized as follows:

1. Rearing calves take to silage from about 3 weeks old.

2. Yearling stores thrive and grow well on a ration of 20 lb. silage, 7 lb. hay and 3 lb. concentrates. Outwintered stock take to silage with avidity, and a daily ration of 20 lb. silage and 3 lb. hay is sufficient to keep them in good condition.

3. Two-year-old stores of 8–9 cwt. winter satisfactorily on 30–40 lb. silage, with oat straw, but an addition of 3 or 4 lb. concentrates is generally advisable. Very little winter fattening is practised, but some farmers bring their forward stores to gradable condition on rations containing 50–60 lb. silage.

4. Nurse cows respond particularly well to silage feeding. When outwintered, they need a ration of about 40 lb. a day.

COPPER DEFICIENCY IN PEARS

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The symptoms of copper deficiency in pear trees as recorded on a light sandy soil in north-west Surrey are described in this article. Of the various treatments tried in an attempt to cure this deficiency disease, spraying the leaves of the trees in May with a weak solution of copper sulphate was by far the most effective.

COPPER has now been shown to be an essential nutrient for a wide range of crop plants, and a number of characteristic disorders result when there is a deficiency of this element. Among others may be mentioned the Yellow Tip or " reclamation disease " of cereals, and Exanthema or Summer Die-back of fruit trees. Exanthema of citrus was first reported from Florida in 1875 by Fowler(1) who believed it to be due to a fungus disease. The origin of the use of copper compounds to cure the condition is obscure, but Floyd(2) reported their use in 1913. Since then, copper deficiency has been observed in most tree fruits and in many of the fruit-growing countries of the world, including the U.S.A., Australia, New Zealand, and South Africa, mainly (although not exclusively) on organic and light soils. It was first reported in Great Britain by Jones(3) and by Bould *et al.*(4).

The case of severe copper deficiency in pears described in this paper was first observed by the authors in 1948 on a large commercial nursery in north-west Surrey, the trees being grown in nursery rows. The soil on which the trees were growing was derived from the Bracklesham Beds (Middle Bagshot), freely or excessively drained and slightly podsolized, and characterized by 12–18 inches of light brown loamy sand, containing some flint pebbles, over 6–12 inches of yellow brown compact sand, patchily cemented with iron, and finally a greenish-yellow sand or, in places, a sandy clay. Soil analysis gave the following results :

	pH	*Phosphate*	*Potash*	*Magnesium*	*Percentage of Nitrogen*	*Percentage Loss-on-Ignition*
0-6 inches	5.8	High	Medium	Low	0.12	2.76
6-12 inches	5.6	High	Medium	Low	0.10	2.48

The first stage of the trouble appeared to be an ill-defined chlorosis along the edge of the leaf, often accompanied by a certain amount of upward cupping towards the tip. With some varieties the leaves of copper-deficient trees appeared to be a darker green than those of healthy trees. The chlorosis was followed by a black scorch which usually started at the tip of the leaf, the leaf finally rolling up and dying. During the late summer, the terminal bud of the current year's growth died, the end leaf often hung over black and shrivelled (Wither-Tip) and the die-back proceeded for a considerable distance down the stem. In the following year multiple branches grew from buds below the dead tip, and these in turn died back towards the end of the summer. The final stage was either the death of the tree or, more usually, stunted trees full of dead twigs and with a peculiarly rough and scaly bark (see p. iv of art inset). The leaves of Quince A rootstocks appeared to show a marginal and interveinal chlorosis but very little die-back.

On this nursery, die-back due to copper deficiency has been observed to be severe on the following varieties : *Beurré d'Amanlis, Beurré Diel, Doyenne du Comice, Beurré Superfin, Jargonelle, Dr. Jules Guyot, Bergamotte*

d'Esperen, Fertility, Beurré Clairgeau, and *Beurré Easter. Beurré Hardy, Conference, Marguerite Marrillat, Josephine de Malines* and *Durondeau* appeared to show some small degree of resistance. All of the above varieties were worked on Quince A rootstocks except *Jargonelle, Marguerite de Marrillat* and *Josephine de Malines,* which were double worked on *Beurré Hardy* and Quince B.

Experiments with Different Treatments In May 1949, after all dead wood had been pruned away, twelve trees were sprayed with 0.1 per cent copper sulphate solution to which a "spreader" had been added. By the end of August the treated trees had made excellent growth and were completely free from die-back, while control trees were showing typical symptoms of the disorder.

The following winter it was decided to lay down a larger trial, and a badly affected area of about seven hundred trees made up of *Beurré d'Amanlis, Beurré Diel, Beurré Easter, Beurré Hardy, Beurré Superfin, Doyenne du Comice, Durondeau* and *Dr. Jules Guyot,* was selected for the purpose. The treatments listed below were decided upon, each treatment being replicated and randomized five times, covering, so far as was possible, all the varieties in the experimental area. As 0.1 per cent copper sulphate solution had been shown to cause a small amount of foliage damage, the treatment applied during the growing season was cut to a 0.075 per cent solution.

1. Control (No treatment).
2. 0.075 per cent copper sulphate solution applied as a spray in May.
3. 4 per cent copper sulphate solution applied as a spray in February.
4. Bordeaux mixture (10 lb. copper sulphate, 15 lb. hydrated lime, 100 gal. water) applied as a spray in February.

Adjoining the main trial were some eighty trees of the variety *Durondeau* which showed some die-back and these were also made available for experimental purposes. During the winter of 1949–50 half of these trees were given a soil dressing of copper sulphate at 30 lb. per acre. It was also decided to test the susceptibility of cherries to copper deficiency, and a small block of young trees of the following varieties was planted in the middle of the experimental area during the same winter: *Biggarreau Gaucher, Bradbourne Black, Bedford Prolific, Black Tartarian, Black Heart, Early Amber, Emperor Francis, Early Rivers, Governor Wood, Morello, May Duke, Noble, Noir de Guben, Napoleon, Ohio Beauty, Roundel Heart, Turkey Heart, Waterloo, White Heart* and *Webb's Black.*

Comparison of Results During 1950, the same striking control of copper deficiency as in 1949 was obtained from the weak copper sulphate spray applied in May, the treated trees being completely free from any signs of the disease and making satisfactory extension growth. The strong copper sulphate solution and Bordeaux mixture applied in February appeared to give only a partial control and growth was unsatisfactory. The soil treated trees, too, still showed marked symptoms of copper deficiency.

The various treatments were repeated during the winter and spring of 1950–51, and the figures given in the following table show the results obtained by September 1951 ; the corresponding figures for September 1950, are shown in brackets :

Percentage of Trees affected by Copper Deficiency

	Treatment	*Severe*	*Moderate*	*Free*
1.	Control	63 (85)	34 (15)	3 (0)
2.	0.075 per cent copper sulphate spray	0 (0)	0 (1)	100 (99)
3.	4 per cent copper sulphate spray	1 (39)	53 (47)	46 (14)
4.	Bordeaux mixture	12 (68)	66 (19)	22 (13)

The average heights in September of the trees treated were : Control—27 inches ; 0.75 per cent copper sulphate solution—51 inches ; 4 per cent copper sulphate solution—36 inches ; Bordeaux mixture—33 inches.

Comparison of the figures in the table shows that there was a slight general improvement in the trees during 1951, possibly due to climatic factors. Nevertheless, the excellent control of copper deficiency symptoms and satisfactory growth following the use of a dilute copper sulphate spray during the growing season was again found in 1951. From other spraying carried out on the nursery it would appear that May is the best time to do this and that late sprays may not be completely effective.

Neither a strong copper sulphate spray applied during the dormant season nor Bordeaux mixture has given complete control of the disease, the latter being the more inferior in this respect. Both treatments appear to have some cumulative effect in that the 1951 results were much better than those obtained in 1950, and it would appear probable that the continued use of either of these sprays would eventually give a satisfactory control. The soil treated trees were still showing slight signs of the disorder in September 1951 and two dressings of copper sulphate at 30 lb. per acre have not completely cured it. No symptoms which could be attributed to copper deficiency appeared on any of the cherry trees.

Copper Content of Leaves Leaf samples from the various treatments were analysed for copper content and, since the figures are of some interest, they are given below :

Copper in Dry Matter of Leaves (parts per million)

Control	1.0	Bordeaux mixture	4.0
0.075 per cent copper sulphate solution ..	6.5	Soil treatment	5.0
4 per cent copper sulphate solution ..	1.3		

In general, the copper content of the leaves is reflected in the relative health of the trees, although the figure from the trees treated with 4 per cent copper sulphate solution appears to be rather low. Some authorities have found a higher nitrogen content in leaves from copper-deficient trees but this effect was not obtained in these experiments.

The writers are greatly indebted to Messrs. E. Beckley (County Horticultural Officer) and F. A. Bush (District Horticultural Officer) of the Surrey N.A.A.S. for assistance in this experiment.

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EFFECT OF FERTILIZER ON THE TEXTURE OF CANNED PROCESSED PEAS

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A series of experiments to test the effect of applying fertilizers to threshed peas was carried out in 1946-49, and a short account of the results obtained was published in the March issue of AGRICULTURE. Other trials were carried out with the canned produce from some of these experimental plots to find out to what extent the manuring had affected the texture of the flesh and skin of the peas.

IN this country, peas canned in the immature state are known as "fresh garden peas," and those canned in the fully mature state as "processed peas." Very large quantities of the latter are produced each year and it is important to ensure that the peas harvested for this pack are of such quality that the texture of the canned product will be uniformly tender. The experiments described below were an extension of a series of field trials carried out under the aegis of the Agricultural Improvement Council, which had been planned at the Rothamsted Experimental Station and conducted by the staff of the Home Grown Threshed Peas Joint Committee in conjunction with the National Agricultural Advisory Service. These field trials, which have been described in a previous paper by Crowther *et al.*(1), tested the effects on the yield of threshed peas of applying three fertilizers at three different rates and in all combinations, the main treatments per acre being as follows :

N_0 = No nitrogen.
N_1 = 0.2 cwt. N as 1 cwt. ammonium sulphate.
N_2 = 0.4 cwt. N as 2 cwt. ammonium sulphate.

P_0 = No phosphorus.
P_1 = 0.5 cwt. P_2O_5 as 2.5 cwt. superphosphate.
P_2 = 1.0 cwt. P_2O_5 as 5.0 cwt. superphosphate.

K_0 = No potassium.
K_1 = 0.6 cwt. K_2O as 1 cwt. potassium chloride.
K_2 = 1.2 cwt. K_2O as 2 cwt. potassium chloride.

The present article deals with canning trials on samples of peas from four of the 1948 experimental centres (D, F, I, K) used during the field trials, carried out to ascertain whether the use of fertilizers had any effect on the texture of peas when canned, and if such effect differed according to whether the peas were canned in soft or hard water.

The toughening effects of salts of calcium and magnesium present in the water used for the various canning operations has been demonstrated by Horner(2), and may be attributed to the combination of these salts with pectic material in the skin and flesh of the peas. Toughening can also occur when dried peas are held in store, and Mattson(3) has suggested that this may be due to the breakdown of phytin through the action of the enzyme phytase, whereby the calcium and magnesium which it contains are released and combine with pectic substances to give a tough cementing material between the cell walls. Toughening appears to be less when harvesting conditions are damp and the temperature low ; rapid drying and warm conditions of storage tend to produce tough or uneven texture.

Initial Treatment The samples of peas were first sorted to remove grub-eaten and other damaged peas. Each set of samples (27 lots) from each growing centre was then split into two batches (14 and 13 lots respectively) and the peas in the first of these batches were put to soak at a suitable hour to be ready for canning in A1-size cans next morning (20 hours later) ; the second group of samples was put to soak so as to be ready for canning in the afternoon. In all subsequent operations, the conditions were kept as nearly constant as possible for the samples within the batches, but to eliminate possible errors due to the order of placement, the sequence of canning was randomized. The cans were stored for an appropriate time before testing for texture. Each sample was canned in two types of water, one distilled, and the other a medium-hard water of 12 degrees total hardness.

Testing for Texture The ultimate criterion by which texture must be judged is the subjective impression recorded in the mouth. This form of measurement is, of course, open to serious personal errors, but the significance of these can be greatly reduced by having a large number of replicates for each sample tested. The measurement of texture in these present tests was made in two ways : by an objective mechanical test, using a tenderometer, and by the personal judgment of experienced "tasters." The tenderometer—an instrument commonly used in the United States to measure the texture of raw, immature peas required for canning or quick freezing—measures the shearing force required to drag a sample of peas through a metal grid, the maximum shear being recorded on a scale in lb. per square inch. In these tests the range was 19–49 lb. per square inch.

In the personal judgment tests the full range of samples was tested by five experienced persons, the texture of flesh and skin being recorded separately, each on a scale of 0–10 according to toughness (most samples were within the range 2–5). The testers were instructed to take at least six peas from each sample since the texture of the individual peas varied appreciably. The order of judging was randomized and each sample bore a code letter the key of which was unknown to the testers. Testing was done in complete batches of 27 and two samples were carried over into the next batch, with the average scores previously awarded, to enable the testers to have fixed points for comparison within and between each batch.

Examining the Results One complete set of samples (216 cans) was put through the tenderometer. The mean readings obtained for the different fertilizer treatments are shown in Table 1. Statistical analysis of the original data revealed that there was no significant difference in texture caused by the application of the three fertilizers in the case of the samples canned in distilled water. When a medium-hard water was used, however, there was significantly less toughening of the peas from one centre (D) where nitrogen fertilizer had been used for the crop.

The personal judgment method of testing for texture was found to be not only natural but also reliable ; and, moreover, it differentiated between skin and flesh. The tests on samples treated with distilled water were repeated with a second series of cans, and the two sets of figures agreed closely. The results are presented in Table 2. Statistical analysis of these results showed that: (1) of the samples treated with *distilled* water, the addition of nitrogen resulted in a firmer texture of the flesh of peas from three centres (D, F and I) and of the skin of peas from two (D and F) ; the addition of phosphorus resulted in a firmer texture of the flesh of peas from one centre (K) ; potas-

Table 1

Mean Tenderometer Readings

(lb. per square inch)

(a) DISTILLED WATER

Centre	Nitrogen			Phosphorus			Potassium		
	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2
D	19.87	19.89	20.63	19.95	20.09	20.35	19.89	19.63	20.87
F	30.92	30.29	29.47	30.39	30.42	29.88	30.69	30.42	29.57
I	31.39	32.20	30.29	30.81	31.66	31.29	31.54	30.19	31.94
K	28.52	29.06	30.82	29.84	29.99	28.57	29.92	29.21	29.27

(b) MEDIUM-HARD WATER

Centre	Nitrogen			Phosphorus			Potassium		
	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2
D	34.99	30.30	27.00	31.06	32.48	28.75	30.76	29.81	31.72
F	48.28	43.50	44.61	47.39	45.00	44.00	45.52	43.64	47.22
I	39.72	40.17	37.89	39.11	41.11	37.56	39.06	38.44	40.28
K	35.28	36.28	35.61	35.33	37.22	34.61	37.06	35.17	34.94

Table 2

Mean Personal Judgment Scorings (by mouth)

(a) DISTILLED WATER (*Flesh*)

Centre	Nitrogen			Phosphorus			Potassium			Significant Difference between Means ($P=0.05$)
	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2	
D	2.80	3.12	3.69	3.08	3.12	3.41	3.29	3.11	3.21	0.37
F	3.02	3.16	3.53	3.08	3.11	3.52	3.26	3.10	3.36	0.30
I	2.78	3.18	2.96	2.88	2.97	3.07	2.78	3.04	3.09	0.27
K	3.26	3.44	3.40	3.28	3.47	3.36	3.36	3.47	3.28	0.30

In Centres D, F and I, scores *increased* significantly with N.
In Centre F, scores *increased* significantly with P.
In Centre I, scores *increased* significantly with K.

(b) DISTILLED WATER (*Skins*)

Centre	Nitrogen			Phosphorus			Potassium			Significant Difference between Means ($P=0.05$)
	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2	
D	2.12	2.31	2.72	2.31	2.26	2.58	2.40	2.26	2.49	0.43
F	2.94	3.18	3.31	3.12	3.05	3.26	3.23	2.98	3.22	0.19
I	3.32	3.41	3.30	3.32	3.34	3.37	3.33	3.31	3.39	0.28
K	3.47	3.49	3.50	3.39	3.63	3.44	3.52	3.53	3.42	0.20

In Centres D and F, scores *increased* significantly with N.

(c) MEDIUM-HARD WATER (*Flesh*)

Centre	Nitrogen			Phosphorus			Potassium			Significant Difference between Means ($P=0.05$)
	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2	
D	2.67	2.73	2.82	2.93	2.91	2.80	2.82	2.78	2.80	0.34
F	4.00	3.92	3.98	4.09	3.92	3.89	4.00	3.98	3.92	0.44
I	3.98	4.20	4.26	4.18	4.15	4.22	4.07	4.15	4.22	0.39
K	3.16	3.38	3.33	3.33	3.36	3.18	3.22	3.34	3.31	0.35

No significant differences in scores.

(d) MEDIUM-HARD WATER (*Skins*)

Centre	Nitrogen			Phosphorus			Potassium			Significant Difference between Means ($P=0.05$)
	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2	
D	3.13	2.93	2.78	2.95	2.98	2.91	2.88	2.98	2.98	0.27
F	4.40	4.41	4.29	4.42	4.25	4.13	4.33	4.22	4.25	0.39
I	4.06	3.98	4.27	4.13	4.18	4.00	4.02	4.09	4.20	0.35
K	4.00	3.84	3.69	3.78	3.93	3.82	4.02	3.73	3.78	0.30

In centres D and K, scores *decreased* significantly with N.

sium increased the toughness of one centre (I) ; and (2) of the samples treated with *medium-hard* water, there was no significant difference in texture of the flesh of the peas from any centre by any treatment, but the addition of nitrogen produced a reduction in firmness of the skin of peas from two centres (D and K). This last result confirms the trend shown in the tenderometer readings.

Conclusions The application of nitrogen (as ammonium sulphate) for the growing crop tended to cause toughening of the texture of skin and flesh in the resulting peas when they were canned as " processed peas." At three of the four centres this was found to be particularly true when distilled water was used in the canning processes. The addition of phosphorus (as superphosphate) resulted in tougher flesh of the peas from one centre when distilled water was used in canning ; potassium (as potassium chloride) had a similar effect on the flesh of peas from one centre. Where a medium-hard water (12 degrees of hardness) had been used for the canning processes, no differences in texture were discerned when tested by the mouth, except that the addition of nitrogen resulted in less toughening of the skins of the peas from two centres, a result which confirmed the findings for texture recorded mechanically by means of a tenderometer. This apparent reduction in affinity for calcium is of interest.

It is important to note that, although some of these results are statistically significant, they are of little practical importance because the differences recorded (0.3–0.8 point) are mostly below that which can be readily detected on a single sample by an expert, and they would certainly not be detected by most consumers. Differences become evident only when a large number of samples is taken. The tests do, however, show a general trend, even though this has not yet been correlated with soil analysis or other factors associated with the growth of the peas.

The author is indebted to Messrs. Batchelor's Peas (Southall) Ltd. for facilities to use a tenderometer at their factory, and to the Home Grown Threshed Peas Joint Committee for supplying the samples for the tests. He also wishes to acknowledge advice in connection with the statistical treatment of the data from Dr. E. M. Crowther and the Statistics Department of the Rothamsted Experimental Station, and from Dr. T. G. Gillespy of the Campden Research Station.

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FARMING AFFAIRS

Farming Cameo :
18. Abergavenny, Monmouth

The Abergavenny district is cleaved by the lovely vale of Usk. To the west and north, steep, wooded slopes rise to heights of 1,900 feet where mountain sheep flocks graze. To the east and south, gently undulating plains roll like a swell on a fast-calming sea. For this is a district of major contrasts.

To the west, the soils are dark and sullen, far richer in coal than in crop fertility, while to the east they are a deep, rich red, rich also in those inherent characteristics that make for good crops of high quality. In the west, the annual rainfall often rises to 80 inches, whereas in the east the rainfall is, on occasions, below 30 inches. The west is lingeringly Welsh, the east is monoglot English. Westwards, the dominant farming system is hill sheep and hill cattle with some dairy farming here and there ; eastwards, the farming is mainly devoted to intensive milk or beef production with ample scope for good, profitable arable crops. In this area, market gardening has made great strides during the last decade and has created for itself a reputation which is the envy of many. It is doubtful whether such a wide range of conditions and such a vast variety of farming systems could be found elsewhere within the compass of about 50,000 acres of agricultural land.

Under such contrasting conditions of management and production, averages can be most misleading. An average-sized farm is 62 acres with 20 acres of tillage, 10 in temporary grass and 32 in permanent grass, but the lowland farms are larger and have a higher proportion of tillage, while the sideland, upland and hill farms are smaller with less tillage and more truly permanent and unploughable grazing swards. The smaller farms have extensive common hill rights for hill sheep and store cattle grazing.

Farm production of the district is based upon livestock and grass ; in all, there are some 14,000 cattle, 60,000 sheep and 30,000 acres of grass. The main livestock enterprise on the lowlands is dairying, the popular breeds being Dairy Shorthorn and British Friesian, though Red Poll and Ayrshires are strong competitors for the farmer's favour. But herds of Hereford beef cattle, for which this district was once so famous, are still to be seen in goodly numbers. These cattle are often fattened off the permanent summer grazings —a practice which produces animals of the first quality. The raising of Hereford Cross store cattle is still a profitable subsidiary enterprise on many dairy farms, though the spread of attestation is reducing their numbers.

Sheep, too, are of two distinct types. The hill breeds are Welsh Mountain and Welsh Mountain × Radnor ; the lowland breeds are Radnor × Clun Forest mated to Suffolk, Oxford, or other Down rams, for the production of fat lambs.

Tillage in the uplands is designed to provide some winter fodder and to maintain the quality of the hayed swards. On the lowlands, an eight-course rotation of wheat—mixed corn—roots—oats and a four-year ley is generally adopted, the cash crops being wheat, seed corn, potatoes and sugar beet.

The district centre is the delightful market town of Abergavenny—a town in the midst of exquisite natural scenery and great sylvan beauty. Houses of many periods line its ancient and narrow streets, through which today pass draft ewes from the adjoining hills, fat lambs from the plains, and store and fat cattle, all travelling eastwards ; for much which is the pride of England saw birth here.

R. W. Baker
District Advisory Officer

Compulsory Treatment of Warbled Cattle At this time of the year it is as well to remember our statutory obligation to free cattle of warbles. It is often an irksome duty and one which seems to bring little benefit ; there are a number of farmers who neglect to carry it out so that warble flies from these bad neighbours can easily cross the farm boundary to keep the pest going. The warble fly works in an insidious and subtle way so that it may scarcely be noticed, though it is obvious to anyone that a beast having anything from ten to a hundred great fat maggots, each in an open, discharging, purulent abscess along its back, is unlikely to do as well as an animal free from this trouble.

The Warble Fly (Dressing of Cattle) Order directs that all affected cattle must be treated with derris wash at monthly intervals from mid-March to the end of June. This is especially important with young stock, although they may be relatively inaccessible in some out of the way grazing and be wild and difficult to handle. Imported Irish stock are often heavily infested and require careful watching to avoid the risk of reintroducing the parasite into cleared areas. Effective treatment demands that the beasts' backs should be scrubbed to dislodge the encrusted discharge and loosen the matted hair around the orifice of the ulcers in order to allow the derris to come in contact with the maggot ; otherwise the parasite can escape unharmed.

By way of encouragement in our efforts, it is worth recalling that in Cyprus a co-operative effect succeeded in eradicating the disease completely in a short time, and that efforts made in Denmark have resulted in virtual eradication since the war.

Farm Incomes in England and Wales, 1949–50 A third report in the series published by the Ministry of Agriculture and Fisheries on the results of the Farm Management Survey in England and Wales* has just been issued. This report, which summarizes the financial data for an identical sample of 2,588 farms for 1949-50, compared with 1948-49, shows that there was a slight general decline in net incomes in 1949–50 throughout the country, with very few type-districts showing an increase. The dairying group appears to have been, on the whole, least affected. The following table gives net income figures for the type-of-farming areas into which the 2,588 farms are grouped.

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* *Farm Incomes in England and Wales, Series No. 3, 1949-50.* H.M. Stationery Office, or through any bookseller, price 6s. (6s. 6d. by post).

	Net Income per Farm		Net Income per 100 Adjusted Acres	
	1948–49	1949–50	1948–49	1949–50
	£	£	£	£
Mainly dairying	847	766	660	597
Dairying and mixed	1,114	1,089	626	611
Mixed livestock (upland)	613	564	426	391
Mixed livestock (lowland)	858	744	483	418
All grass	817	752	552	507
Mixed with substantial dairying ..	1,080	913	614	519
General mixed	1,285	1,043	703	570
Corn, sheep and dairying	1,609	1,682	416	432
All intermediate	1,266	1,106	587	512
Heavy land arable	1,630	1,254	700	537
Light land arable	1,508	1,269	665	557
Arable and mixed with alluvial arable	1,242	1,245	1,086	1,083
All arable	1,418	1,257	781	690
All type-groups (excl. specialist) ..	1,079	967	622	556
All type-groups (incl. specialist) ..	1,080	970	632	567

The percentage of farmers showing a deficit in 1949–50 was 7.2 as against 5.2 in the previous year, but only 1.9 per cent showed a deficit in both years. Nearly 32 per cent of the farms made profits of over £1,000 in 1949–50, compared with 36 per cent in 1948–49. Some 24 per cent made profits of over £1,000 in both years.

Total farm revenue was higher in all type-groups, apart from the relatively small Market Garden (Wales) district. The dry summer of 1949 reduced the yields of root crops below the 1948 level, and with smaller acreages under wheat and potatoes it is not surprising to find that revenue from crops, adjusted for the value of crops harvested but unsold at the end of the accounting year, was a little lower in 1949–50 than in 1948–49. On average, revenue from livestock increased by just over £1 per acre. Revenue from pigs doubled, but there was only a slight increase in revenue from sheep, while sales of dairy cattle declined. Milk production continued to increase and revenue was up by about 18s. per adjusted acre.

Farm expenditure generally showed an increase of between 11 and 12 per cent during the year. The cost of labour rose by some 5 per cent, chiefly as a result of the agricultural wage award of March 1949, but expenditure on labour varied greatly with the type of farming, and the importance of farmer and wife labour on certain farms is clearly illustrated in the report. The cost of purchased foods rose by over 50 per cent as a result of the partial removal of the subsidy in March 1949. Expenditure on fertilizers, rent, machinery and other miscellaneous items was also higher in 1949–50.

In addition, the report gives much detailed information by type-districts and size-groups including analyses of net output, gross output and social income.

Dutch Canned Vegetables : A Growing Export Amongst the various systems of processing vegetables in the Netherlands, preservation in tins and in jars is by far the most important. It is quite safe to state that nearly all kinds of vegetables grown in the Netherlands in smaller or larger quantities, according to the demand for these products, are purchased by canners for preservation in tins or jars.

The following table sets out the quantities of the principal vegetable crops bought for preservation in tins or jars.

Quantities Purchased for Processing in Tins or Jars
(metric tons)

Vegetable Crop	*1947*	*1948*	*1949*	*1950*
Endive	533	1,871	1,655	1,776
Gherkins..	1,942	1,044	3,527	3,915
French beans	4,474	6,575	9,065	11,639
Other kinds of beans	1,181	2,411	2,406	3,566
Green peas	14,849	16,474	32,133	21,974
Carrots	1,237	2,632	6,462	4,996
Spinach	9,187	8,113	10,190	6,965
Tomatoes	10,229	4,583	10,129	7,622
Other vegetables	2,613	4,552	4,759	5,096
Total	**46,245**	**48,255**	**80,326**	**67,549**

To the Dutch canning industry, exportation is of primary importance. Every possible endeavour is made to expand exports and to offer to foreign buyers articles complying with the requirements of the consumers in any country. The demand for Dutch canned vegetables is steadily growing, notably by Germany, Sweden, Switzerland, and the U.S.A. Exports to the United Kingdom in recent years, compared with total exports, is shown below :

(metric tons)

	1935–39	*1947*	*1948*	*1949*	*1950*
United Kingdom	66	1,606	4,596	19,098	8,732
Total Exports	1,287	3,553	7,965	24,281	14,796

Industrial Fibres A substantial increase in the world production of fibres in 1951–52, possibly to a level exceeding the record of 29,200 million lb. reached in 1940, is foreshadowed by the Commonwealth Economic Committee's recently published review* of production, trade and consumption of the chief industrial fibres during the post-war years.

In 1950–51, world output of fibres rose by only 1 per cent compared with the previous year, and by some 8 per cent in comparison with 1938. The fact that the increase was so small is mainly attributable to the sharp decline in the production of *cotton* (which accounts for about one-half of the entire fibre output of the world) resulting from the severe restrictions in acreage and low yields in the United States of America. However, a near-record crop of cotton is expected in 1951–52, early estimates putting it at about 16,000 million lb., as against the 13,800 million lb. of 1950–51.

Of the other fibres covered by the survey, there was a slight increase in 1950–51 compared with 1949–50 in *apparel wool* to 1,875 million lb. (clean

* *Industrial Fibres.* Obtainable from H.M. Stationery Office, or through any bookseller, price 5s. (5s. 3d. by post).

basis) and a 4 per cent rise in *carpet wool*. *Silk* production fell slightly but *flax* increased by 13 per cent, and *hard hemp* by 10 per cent, the latter advance being due to the continued recovery of the Philippines—the largest pre-war producer. *Jute*, at 3,100 million lb., was 500 million lb. up on 1949–50, a position which contrasted sharply with the declining trend of the previous three years. With both Pakistan and India having expanded the area under jute in 1951, the new crop is expected to be even larger. Perhaps the most outstanding increase recorded, however, was in *rayon* where output was 29 per cent higher than in 1949–50, with the anticipation of a further 12 per cent in 1951–52.

Although it is difficult to form an accurate assessment of world consumption of all the fibres dealt with by the review, it would appear that demand for the apparel fibres was about 14 per cent greater in 1950–51 than in the previous year. Consumption of cotton, accentuated by purchases for defence and stock purposes, was higher than pre-war, and as the result of the decline in production, world stocks were heavily drawn upon. Similarly, wool consumption exceeded output by about 360 million lb. Of considerable interest, too, was the enhanced demand from the wool textile industry for rayon and other substitute fibres.

World trade in all fibres increased by 12 per cent in 1950 compared with the previous year and, for the first time since the war, was greater than in 1938. The United Kingdom remained the chief importer and took greater quantities of flax, hemp, and jute, but smaller amounts of the apparel fibres, than in 1949. The United States regained its position as the largest importer of wool and took more of all the fibres which it imports. Germany and Japan also bought considerably more than in 1949, although neither has yet resumed importing on the pre-war scale.

The Commonwealth continued to produce almost all the world's jute and half its wool. Its share in hemp production (rather less than one-third) declined slightly, largely as a result of the increase in output of other countries such as the Philippines. The Commonwealth proportion of cotton production, however, rose in 1950–51.

Prices of the main industrial fibres fluctuated violently in the United Kingdom during the 1950–51 season. After being relatively stable in the first half of 1950, they increased rapidly after the outbreak of the Korean war, reaching their peak in the spring of 1951. In many cases, though, they declined considerably during the summer, and by November the prices of most fibres had fallen to the level prevailing at the beginning of the year. Wool prices were actually the lowest since the spring of 1950.

BOOK REVIEWS

Poultry Science and Practice (3rd Edition). A. R. WINTER and E. M. FUNK. Lippincott. 45s.

This standard American text-book was previously produced in 1941 and 1946. While a fair amount of the material is specific to American conditions, there is plenty of matter of general interest to poultrymen in this country. Although this edition has been reset in a smaller type, the book has not suffered in readability. Many chapters are almost unaltered, but greater detail of the National Poultry Improvement Plan, which corresponds to our Poultry Stock Improvement Plan, is included and short references to chemical caponization, vitamin B_{12}, the animal protein factor, and the use of condensed fish solubles appear for the first time. There are also interesting fresh data on amino-acid requirement and sources, and growth requirements.

No date is given for this latest revision, but I was surprised to note that the Recommended Nutrient Allowances of the National Research Council are those of the 1946 revision ; the 1950 revision has not been taken into account in this volume. It is disappointing to find

that recent developments in vitamins receive such scant attention, and that the burning question of antibiotics is studiously ignored. There are certain irritating mis-spellings of the names of authors of references, which indicate hurried proof-reading.

In the section on turkeys, only a brief reference is made to the Beltsville Small White, and none at all to the Broad Breasted Bronze, which, in view of the tables dealing with consumer demand for turkeys, might well have merited some attention. Sections on ducks, geese and game birds are also included.

The book is well produced, and the illustrations and references are, on the whole, well selected ; the volume is rounded off with some useful general tables.

W.M.A.

A History of Scottish Farming. T. Bedford Franklin. Nelson. 12s. 6d.

This is the most recent addition to an excellent series on all aspects of agriculture. Well printed on good paper, and modest in size, it is easy to handle and read.

The author comes to his task adequately equipped, for his previous study of monastic agriculture attracted both attention and respect. Scotland has lacked an agricultural historian, and while there have always been quite good records from the eighteenth century onwards, the student has been discouraged by the gloomy picture drawn by contemporary writers at that time. It has not been fully recognized that the national renaissance arising from the 1715 and the 1745 struggles brought new life to all Scottish activities, including agriculture, which had been in the doldrums since the collapse of monastic agriculture. The beneficent effect of the religious settlements at Dunfermline, Coupar-Angus, Newbattle, Melrose, Dundrennan and Glenluce had been forgotten, and Scotsmen, afflicted with questions of religious dogma, had forgotten that mundane subjects required attention. Stevenson said you keep no men long, nor Scotsmen at all, from discussing theology. The freedom of the church and the individual, as witnessed by the Covenanting era, so filled the minds of the people that it was no wonder sixteenth century travellers in the country remarked on the hovels and the decadent agriculture, as compared with conditions in England. Mr. Franklin therefore does well in depicting the good husbandry which preceded this unfortunate period and quite rightly devotes most of his book to the earlier centuries.

The first impression that the author has crowded the last two centuries, the period of progress, when the Scots led by the landlords transferred their ardour to agriculture and became acknowledged masters of their craft, into too small a compass, is destroyed on reading, for the last chapters, although condensed, convey an adequate picture. In these chapters there are a few points of opinion that might be questioned, but to fasten on these for criticism would be petty, in view of the excellence of the whole.

The student can be assured that with this little volume he need no longer struggle through the Statistical Accounts nor read through (although not without other rewards), the pages of Trevelyan and Ernle, to garner authoritative information about Scottish agriculture. True, the subject is worthy of a larger volume, but it could hardly be presented more attractively than in this work. Under test, the index is comprehensive.

T.B.M.

Landwirtschaftlicher Wasserbau (Agricultural Hydraulic Engineering). G. Schroeder. Springer-Verlag. 70s.

Although much can be learned from the many excellent illustrations in this book, the non-German scholar will inevitably regret his inability to translate the text. It is a complete treatise on land drainage and covers not only most of the types of work associated with statutory drainage authorities, but also the smaller, though equally important, work of field drainage. The author does not confine himself to engineering, and logically enough starts with a chapter on soil science, giving the reader that background knowledge of the physical, chemical, and biological aspects of the soil, without which he would fail to understand the real implications of drainage work.

The second chapter is equally interesting, dealing with rainfall, evaporation, and underground water, with a very full section on hydraulic calculations.

The two chapters devoted to brooks, ditches and drainage channels, and to rivers and their banks, are particularly good, and contain many excellent diagrams and photographs illustrating such matters as bank revetments, weed-cutting, etc. The illustrations show the close relationship between the German methods and those used in Great Britain.

Under-drainage is discussed in very great detail, and other chapters deal with pumping installations, irrigation, and reclamation.

E.A.G.J.

BOOK REVIEWS

Economics of a Fruit Farm. R. R. W. Folley. Oxford University Press. 12s. 6d.

There are few books in the horticultural literature of this country concerned with the economic recording of commercial fruit culture, so this contribution by Mr. R. R. W. Folley is very welcome and, indeed, beneficial to both beginners and experienced pomologists. It is solely concerned with apples, and is a record of research carried out during two distinct financial periods. In the first phase, 1932–39, our major industries were influenced by a financial depression when the supply of merchandise was greater than the demand, and large-scale unemployment was a feature. The second stage, 1940–47, was a period of full employment and higher wages, when commodities and human food were in greater demand than supply, and apples could be sold freely without any reference to National Mark standards, and, moreover, importation from overseas was restricted.

The layout of the contents is well balanced, and there are numerous tables and graphs that give details of costings of the various activities and processes that are essential in modern fruit production. Part two, " Economic Derivations and Graphical Section " sets out in appendix form the principal factors, their financial associations and data. This detailed accountancy adds value to the book, and clearly records the major operations and activities.

The opening chapter traces the relationship between the practical grower and the research stations and shows the modern trend towards commercial planting of Cox's Orange Pippin.

The objective of the grower (Mr. R. N. Dixey) was the production of quality apples. Of the 200 acres of land originally purchased, a total of just over 86 acres were devoted to apple growing, of which nearly four acres were planted with " Cordon " apple to give an early financial return. Livestock as a source of nutrition was not included.

Chapter 8 indicates that the financial strain was more acute during the first eight years of the venture but, by 1948, full production had been attained. It is interesting to note the statement that, while the cost of many items has increased threefold, " the price of apples has little more than doubled".

This book will appeal to the modern grower for reference purposes and as a means of checking the economy of the many factors concerned with apple culture.

C.H.O.

Farm Machinery. A. B. Lees. Faber. 21s.

As machinery correspondent of the *Farmer and Stock-Breeder*, Mr. Lees has been in a unique position to see the full effect of all the changes in farm mechanization that have taken place during the last ten years. During this period there has been something of a revolution in agriculture, with a change largely from horse to tractor-power, and the introduction of many new machines and mechanized techniques.

In his book, which is addressed chiefly to the small farmer, the author first sets out the main objects of mechanization, emphasizing the importance of increasing output per man and per acre, and pointing out that unless these requirements are fulfilled, the mere introduction of machinery will not reduce costs. Numerous examples are given of the way in which costs can be reduced by mechanization.

The different types of tractor and the advantages of the system of mounted implements, which allows more use to be made of the tractor's power and simplifies cultivation, farm transport and many other jobs, are briefly described.

Mechanization has facilitated the reseeding of grassland and the application of lime and fertilizer, and the increase in the practice of grass drying and silage-making has made greater use of grass than haymaking.

The number of combine harvesters has increased from 150 in 1939 to 13,500 in 1950, and they have proved their worth particularly in the wet season of 1946. At the same time there have been advances in the mechanization of the growing and harvesting of root crops.

Around the farmyard, milking machinery has been shown to be capable of cutting by more than half the man-hour requirements per cow, and the use of electricity has done much to simplify the sterilization of dairy equipment and to provide a convenient source of power for food preparation and many other jobs.

Mr. Lees has given us a very readable book containing much useful practical advice, but there is, however, some apparent bias in favour of the theories of mechanization associated with one particular tractor and implement firm, and many of the conclusions reached are applicable only to certain limited circumstances.

H. C. G.

The Story of Farm Tools (Young Farmers' Club Booklet No. 24). H. A. BEECHAM and J. W. Y. HIGGS. Evans Bros. 2s.

"Man," said Benjamin Franklin, "is a tool-making animal," and throughout the ages *Homo Sapiens* has lavished his unique tool-making gifts on the implements and equipment of the farm, the primary productive unit of any settled civilization. But the technical development of agriculture has received surprisingly little attention from historians, and it is the user of tools—or even the writer who describes the work of the user of tools—rather than their maker or improver who figures in the standard books. For instance, Robert Salmon, that mechanical genius of the early nineteenth century who has to his credit a quite astounding list of agricultural inventions, is today barely a name ; yet the vast historical literature of his period has found time for detailed and painstaking studies of many of his lesser contemporaries because they wrought not in timber and iron but in the less exacting, though more enduring, medium of the written word.

This latest Y.F.C. booklet, written by an agricultural economist and an agricultural engineer, is, therefore, particularly welcome, for it tells, from the breast-plough to the drill, from the sickle to the combine, the story of the tools upon which we depend for our food. Very sensibly, the book is divided into chapters not on implements but on farm operations, and the result is a lucid, thoughtful and extremely well-illustrated account of the changes in farming equipment and routine from Saxon, and even earlier, times to the present day. For instance, the chapter on the hay harvest begins with the scythe and rake and continues, by way of the mower and tedder, to the hayloader and pick-up baler. The book ends with a good reading list (though does not Pigeon's work in the 1892 *R.A.S.E. Journal* deserve specific mention ?) and a noteworthy list of museums where old farm implements can be seen.

One of the tests of an historical, as opposed to a technical, book is the degree of its ability to stimulate the reader's appetite. And this book leaves one wondering about the quality and status of the men who made the old tools, about the sources of their iron and the routes by which their grindstones reached the remote villages, about their legacy to the factory-system and the manner of its inheritance, about the thoughts and incentives which lay behind alterations and improvements, about the curious failure of steam, so revolutionary in urban industry, to fulfil its early high promise on the farm, about this, that and the other. All of which is as it should be.

But other thoughts will arise in the reader's mind : for instance, even if space forbade more than a mere mention of the milking machine, surely reference to the combine implies at least a paragraph on grain drying and handling equipment ? Indeed, the whole chapter on barn machinery might well have been expanded, since in recent generations an increasing proportion of farm work has taken place in the homestead buildings. There is, too, a surprising error in the caption to Fig. 2, which describes Cruikshank's caricature of the horses with spades as "making fun of the idea of applying steam power to farming". But in reality Hoskyns, whose book this originally illustrated, was one of the great early champions of steam power on the farm, and he was ridiculing not steam power but the possible abuse of it by those who would force it into the old equine grooves, even as in our own time some would degrade the tractor into a "mechanical horse" instead of treating it as a machine in its own right, with its own peculiar properties and qualities. Hoskyns, perhaps the first man to grasp and proclaim the revolutionary importance of the coming of mechanical power to the land, deserves better treatment than this, particularly from technical historians.

N.H.

Corn and Corn Growing (5th Edition). HENRY A. WALLACE and EARL N. BRESSMAN. Chapman and Hall. 27s.

This is a book by Americans. In their language "corn" means maize, and what we call corn they term "grain". It is a new edition (revised by Messrs. Newlin, Anderson and Bressman) of the well-known handbook on maize and maize-growing by Henry A. Wallace and Earl N. Bressman. It recalls the fact that it was in the production of high-yielding hybrid maize on a commercial scale that Mr. Wallace founded his fame and fortune, before entering on his political career under President Roosevelt.

It is so extensively rewritten and modernized (including statistics and scientific results down to 1947) that it is virtually a new book. It is an admirable production, comprehensive, and enlightening, without becoming tediously didactic, and has that masterly simplicity of vision and presentation that is a characteristic of thorough grasp and clear understanding.

Since maize is grown in Britain on so limited a scale, and almost exclusively as summer green-fodder at that, its interest will lie in methods rather than in matter, and its appeal will be rather to the student than to the husbandman. It should certainly be noted by the

tropical-agriculturist-to-be, and by the economist and geographer. To them the exhaustive statistics and the almost incredibly lengthy tabulation of economic uses and by-products of the maize will be most valuable. To the teacher pondering rural science, or curricula for modern secondary school and county college, the problems and projects for community studies of a crop will prove very fertile ground.

For those of us who cherish (with William Cobbett) a belief in the possibilities of commercial maize varieties acclimatized reliably to ripen profitable grain yields in this country, or an interest in the crop's possibilities as an almost ideal silage, it is full of valuable leads, facts and ideas.

F.E.K.

Production of Tomatoes under Glass. P. E. N. HITCHINS. Benn. 10s. 6d.

All glasshouse growers are likely to welcome this book as a most valuable addition to their bookshelves. It is an essentially practical work from cover to cover, and good photographs, diagrams, graphs, and tables further assist the reader.

In the early chapters the author deals with general plant requirements, covering such subjects as soil and air temperature, humidity, light and moisture as they affect tomato production under glass. The chapter on the use and value of fertilizers should be of special value to growers who have not had the advantage of a grounding at a college or institute ; the matter is set out in simple understandable language. It is also gratifying to find a writer who tackles organization and labour and the financial problems in connection with growing this crop. The cost of special techniques such as soil sterilizing are also given. The various types of construction and heating are fully covered with special reference to the small growers' needs.

The cultural advice, if followed, cannot fail to improve the production on many holdings. What the author has to say on the selection of varieties is sound, but mention might have been made of a number of other good commercial varieties grown today. Several problems are brought into their right perspective, e.g., early tomatoes cannot be produced in cold soils, and high standards of grading and packing cannot be achieved without good growing.

The author is to be complimented on covering a wide field so well and completely and for dealing with the business side of production. The book, although primarily written for the commercial grower will be of equal value to the keen amateur.

H.W.A.

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